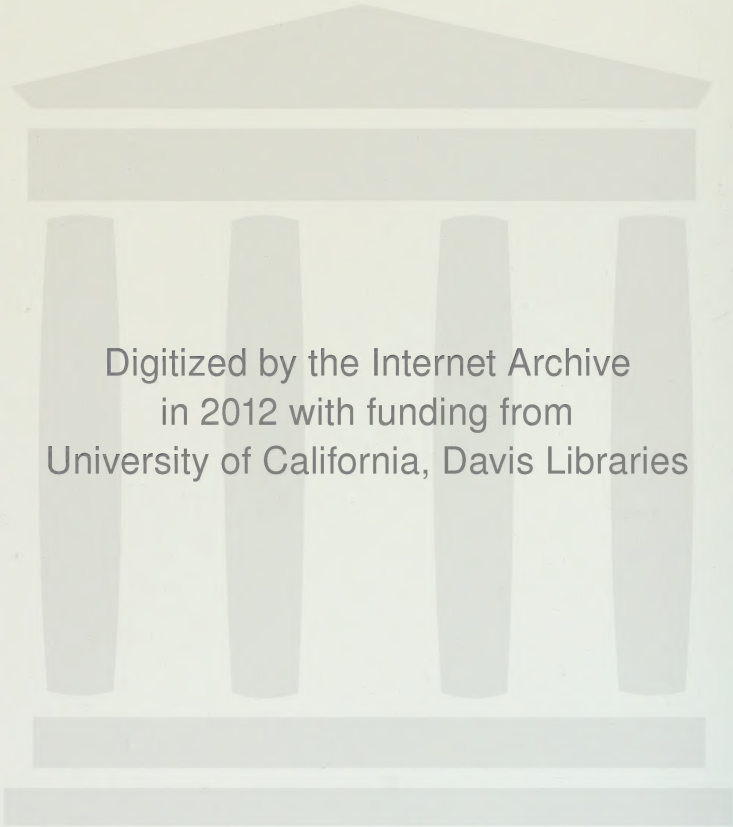
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CALIFORNIA STATE MINING BUREAU
FERRY BUILDING, SAN FRANCISCO
FLETCHER HAMILTON State Mineralogist

San Francisco] [January, 1921

REPORT XVII

OF THE

STATE MINERALOGIST

MINING IN CALIFORNIA DURING 1920

CALIFORNIA STATE PRINTING OFFICE
Sacramento, 1921

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LETTER OF TRANSMITTAL.

To His Excellency, the Honorable WILLIAM D. STEPHENS,
Governor of the State of California.

SIR: I have the honor to present herewith Report XVII of the State Mineralogist, which is a detailed review of mining in California during the calendar year 1920.

The up-to-date and authentic information contained herein has been made possible on account of the fact that the field men in charge of the Bureau's branch offices have been able to establish a close personal contact with the mineral industry, such as never before has been attained. It is believed that this is an innovation which will be appreciated by the mining public, and which will be of real value in assisting in the development of California's mineral resources.

Respectfully,

FLETCHER HAMILTON,
State Mineralogist.

January 1, 1921.

CALIFORNIA STATE MINING BUREAU
FLETCHER HAMILTON
STATE MINERALOGIST
OUTLINE MAP
OF
CALIFORNIA
SCALE
OREGON
NEVADA
ARIZONA
MEXICO
PACIFIC OCEAN
SISKIYOU
MODOC
SHASTA
LASSEN
TRINITY
TEHAMA
PLUMAS
HUMBOLDT
MENDOCINO
GLENN
BUTTE
SIERRA
LAKE
COLUSA
YUBA
NEVADA
PLACER
EL DORADO
YOLO
SONOMA
NAPA
SOLANO
AMADOR
ALPINE
MARIN
CONTRA COSTA
SAN JOAQUIN
CALAVERAS
TUOLUMNE
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
MERCED
MADERA
FRESNO
INYO
SANTA CRUZ
SAN BENITO
MONTEREY
TULARE
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
LEGEND
Mining Division Boundaries.
Mining Division Offices.

INTRODUCTION.

During the year 1920 the field work of the Bureau was carried on through an organization consisting of a chief technical assistant to the State Mineralogist, with headquarters in San Francisco; chief field assistant in charge of the Los Angeles branch office; a field assistant and branch office at Auburn, and a field assistant and branch office at Redding.

The boundaries of each of the four districts, served by the various field offices, are shown on the map printed on the opposite page.

The personnel of the field staff during 1920 was as follows:

San Francisco Field Division:

E. S. Boalich.

W. O. Castello (resigned June).

C. McK. Laizure (January–August).

Los Angeles Field Division:

W. B. Tucker.

Redding Field Division:

E. Huguenin (resigned August).

C. McK. Laizure (August–December).

Auburn Field Division:

C. A. Logan.

At the beginning of the calendar year all field men were instructed to visit every section of their respective districts at some time during the ensuing twelve months and to submit a detailed report covering all phases of the mineral industry in their counties, including general mining conditions, future outlook, and definite data regarding all activity and development work noted.

The results obtained are included in this publication. Some of them are less complete than was originally contemplated, but lack of sufficient funds to adequately man the engineering staff, is responsible for that condition.

In the San Francisco field division in particular it was found impossible to carry on many field investigations which would have been valuable. At the first of the year three men were assigned to that district. By the middle of summer one had resigned, and another was transferred.

The Redding district also suffered from a change of district engineers which, of necessity, took place in the midst of the summer when most of the field work must be done.

However, to the best of its ability, the Bureau is working to carry out in letter and in spirit the injunction of the law under which it was established, which provides that aid and assistance in every possible manner, shall be given California's mineral industry.

In the following pages references, unless otherwise mentioned, are to facts and conditions as of *some* time in 1920. In some instances field work was done by the Bureau previous to that year, but the results had not been published; in that event proper notation has been made.

As is always the fact in the Bureau's work, too much credit can not be given to mine owners and operators, local commercial organizations, and the general mining public throughout the length and breadth of the state.

The cooperation and encouragement received from those called upon by the members of the Bureau are never ending sources of inspiration to attempt to give better service and more service to the industry which brought California into existence and which is capable of expansion beyond the limits of the imagination.

It is not possible to enumerate individual names to whom credit should be given, although they include practically every one mentioned in the report, and many more.

FLETCHER HAMILTON,
State Mineralogist.

SAN FRANCISCO FIELD DIVISION.

By E. S. Boalich.

Part I.

SCOPE OF INDUSTRY.

The San Francisco district, consisting of twenty-eight counties, embraces the central, western, and valley counties of the state, extending from Mendocino and Glenn counties on the north, to and including Monterey, Kings and Tulare counties on the south; also that portion of the southern Sierra Nevadas covered by the counties of Fresno, Madera, Mariposa and Mono. The district includes about 300 miles of the Coast Range, with the foothills and valleys to the east, and also quite a portion of the foothill and high mountain belt of the Sierra Nevada; consequently a great variety of commercial minerals are produced, including most of the structural and industrial materials.

The most important minerals occurring here are: asbestos, barytes, bituminous rock, brick and tile, chromite, cement, clay, coal, copper, diatomaceous earth, dolomite, feldspar, gems, gold, granite, lead, lime, limestone, magnesite, manganese, mineral paint, mineral water, miscellaneous stone, natural gas, petroleum, platinum, potash, pyrite, quicksilver, salt, silica, silver, soapstone and talc.

In the order of their value, the several leading products of the district are as follows: (1) petroleum, (2) cement, (3) quicksilver, (4) gold, (5) miscellaneous stone, (6) brick and tile (including pottery clay), (7) magnesite, (8) salt, (9) manganese, and (10) chrome.

Fresno County leads all others in the value of minerals, due to the petroleum output. Following in order of value of products in 1919, are tabulated the counties in this division:

Value of Mineral Production of San Francisco District by Counties, for 1919, Arranged in the Order of Their Importance. Numbers Preceding Names Refer to Rank in Entire State.

County	Value
4. Fresno	$21,643,898 00
14. Sacramento	2,275,827 00
15. Santa Cruz	2,245,056 00
18. Solano	1,672,084 00
19. Contra Costa	1,395,558 00
20. Alameda	1,304,685 00
21. San Benito	1,276,476 00
22. Santa Clara	1,048,571 00
25. Stanislaus	590,326 00
28. San Joaquin	449,000 00
30. Mariposa	410,535 00
32. Tulare	331,001 00
34. Sonoma	286,038 00
35. Napa	275,303 00
36. San Mateo	241,671 00
37. Marin	228,974 00
40. Monterey	148,504 00
42. Madera	110,683 00
43. San Francisco	65,541 00
44. Glenn	59,637 00
45. Mono	52,682 00
46. Kings	51,283 00
48. Merced	40,350 00
49. Lake	39,375 00
50. Yolo	25,466 00
51. Mendocino	14,214 00
54. Colusa	7,300 00
58. Sutter	----------
Total	$36,290,038 00

GENERAL CONDITIONS DURING PAST YEAR.

FUELS.

Petroleum is the only fuel of importance produced in this district and practically the entire output comes from Fresno County. In spite of the fact that there is a natural decrease in production from all oil wells as time passes after their completion, the standing of Fresno County has been maintained at a constant level for some years. This means that new wells have been continually drilled and that the business is in a most healthy condition.

As a result of the growing oil shortage, efforts to discover new fields are being put forth on every hand. Wildcat wells are now (December, 1920) either being drilled, or plans for such work are being perfected, in the following localities:

Colusa County, west of Williams and Arbuckle.
Yolo County, near Esparto.
Solano County, near Suisun and near Vallejo.
Contra Costa County, near Walnut Creek.
Santa Clara County, near Los Gatos.
Stanislaus County, near Oakdale and near Turlock.
Merced County, near Waterford.
Monterey County, near Bradley and San Miguel.
Madera County, near Lanes Bridge.
Fresno County, near Clovis.
Kings County, southwest and southeast of Hanford.
Tulare County, near Exeter.

METALS.

Gold.

Sacramento and Mariposa counties are the chief gold producers in the San Francisco district. Output in Sacramento comes wholly from dredgers near Folsom and Natoma. In Mariposa there are a few operating quartz mines—a large number of properties appear worthy of further development, but the untenable position in which the gold mining industry finds itself has positively stopped any new operations. The increase in costs of all supplies, labor and transportation during the past four years has made it increasingly difficult for the gold miner to operate at a profit. The gold output of not only California, but of the other western gold states has decreased greatly. Many of the mines have been forced to close down.

The gold miner is decidedly at a disadvantage. The prices of other metals and products can be raised to meet conditions; but the gold miner's dollar, being the base, has to remain at the same face value though its purchasing power has dropped to approximately 47 per cent.

Manganese.

For many years the principal manganese producing section of California has been the Livermore-Tesla district, in Alameda and San Joaquin counties, but exceeded in 1915 by Mendocino and regaining the lead in 1916. In 1918-1919 the largest producing county was Stanislaus, which adjoins San Joaquin on the south, and whose manganese

belt is a part of the same geological province that includes the Livermore-Tesla district. Since the first of the present year (1920) the market has revived and several properties are being reopened both in the Mendocino and the San Joaquin-Stanislaus districts. The following quotations have recently (June 24, 1920) been offered:

44%–49.99% Mn at 76¢ per unit.
50%–52% Mn at 80¢ per unit.
52% and up Mn at 82¢ per unit.

Quicksilver.

Quicksilver production in California during recent years has come from twelve counties, all but three of which are in the San Francisco district, and the three in question (Kern, Siskiyou and Trinity) are relatively unimportant.

PRESENT ECONOMIC SITUATION.

By Walter W. Bradley.

"The famous mines at Almaden, Spain, are the largest world producers. These mines are owned by the government and operated by contractors using convict labor. The cost of production of quicksilver is stated to have increased from $8.29 a flask in 1900 to $15.22 in 1915. Their ore is high-grade, the material sent to the furnaces averaging 9%–11% mercury.

"For two or three years previous to the outbreak of the European war, our normal peace-time consumption of quicksilver in the United States was approximately 25,000 flasks annually; and our domestic production had fallen below 20,000 flasks per year. Of this 25,000-flask peace-time consumption, nearly 50% went into the manufacture of fulminate for explosive caps for mining, quarrying, and sporting arms ammunition as well as military ammunition. Our domestic production being inadequate, partly because of the low price and the lower average tenor of the ores mined, necessitated the importation of up to 5000 flasks annually. The enormous increase in munitions manufacture due to the war temporarily raised our requirements correspondingly.

"There were no imports of quicksilver into the United States for the year 1919. The exports (mainly to the Orient) were 9107 flasks valued at $817,428 for the year.

"The import duty of 10% ad valorem is not sufficient to protect our American miners against the competition of the convict-operated mines of Spain, where quicksilver can be produced for as low as $8 to $15 per flask as noted above. The duty should be at least $25 per flask to give us proper protection. The improvement in the price increased the number of operating properties in California during 1916-1918. Lower grade ores are being worked; and new methods of ore dressing and reduction have been tried.

"Following the signing of the armistice, all but about five of California's mines were closed, owing to the uncertainty of the future. The industry here is in danger of extinction due to the prospect of dumping from Europe, because we have not sufficient tariff protection.

"There are those who have taken the position that we should buy where we can get the metal the cheapest, and let our own industry "go hang," as "it is decadent" anyway. That is certainly not a patriotic attitude; nor a safe one either. Though its total value may be small, as compared with such as gold or copper, yet our American (which means mainly, California) quicksilver business has been an important and vital industry for about 70 years. A quicksilver mine can not be left idle "in reserve" and then opened up at a moment's notice for an emergency.

"If, and when, our American quicksilver industry is extinguished by lower-priced foreign competition, we will then be at their mercy, and they can later raise their price to any figure they want and we'll have to pay it. It is not fair to our American capital invested, nor to our California miners (also Nevada and Texas) not to be given protection against the convict-operated and other cheap-labor mines of Spain, Italy and Mexico.

"The meat of the situation is summarized by the Tariff Commission in the following:[1]

'In the case of quicksilver, the question can be squarely raised as to whether the production of this metal can be considered an effective American industry, inasmuch as abundant, cheaper sources of supply exist elsewhere. It is particularly an example of an industry whose products are placed on the market at high cost because of the relatively inferior natural resources of this country in the raw material.

'Quicksilver is an essential metal, however, of vital necessity in the conduct of war and widely used in the industries. It is stated that American resources, although low grade, can furnish an adequate supply for many years if a stable and sufficient price be guaranteed. Without tariff protection the United States will be dependent in large part on outside sources for a vital commodity, and a grave question of national expediency is involved.'

"In the opinion of the quicksilver men, and the writer, the last sentence, above, is the most important of all.

Uses.

"The most important uses of quicksilver are the recovery of gold and silver by amalgamation, and in the manufacture of fulminate for explosive caps, of drugs, of electric appliances, and of scientific apparatus. By far the greatest consumption is in the manufacture of fulminate and drugs.

"One new use for quicksilver is in the introduction of a small amount into the cylinders of steam turbines to improve the vapor pressure and thus increase effciency. This mercury is recoverable and can be reused, so that there is only a small proportional loss.

"Quicksilver is an absolutely essential element from a military standpoint, as there has not yet been produced an entirely satisfactory commercial substitute for it in the manufacture of fulminating caps for explosives. However, in order to reduce consumption of the fulminate, some potassium chlorate, picric acid, trinitro-tuluol, or tetranitro-methalmine is sometimes mixed with it. The Ordnance Department of the U. S. Army, however, will accept no substitutes, as they have thus far proven unreliable.

Concentration of Quicksilver Ores.

"For the above reason, and the fact that California has been, and still is, producing from 70% to 80% of the quicksilver yield of the United States, an investigation of the possibilities of concentration for

quicksilver ores, was undertaken by the State Mining Bureau. In the Bureau's investigation a wide variety of ores was tested by water concentration, flotation with oils, and a wet method by solution with an alkaline sulphide. Full details of this work, as well as furnace practices and descriptions of the California mines, are given in Bulletin No. 78, issued during 1918.

New Equipment.

"The most notable recent developments in the metallurgy of quicksilver is the adaptation of the rotary cement-kiln to the reduction of quicksilver ore at the New Idria mine, San Benito County. They have there installed five such furnaces, with a combined daily capacity of 500 tons. The lead of the New Idria Company in the matter of rotary furnaces was followed at the Sulphur Bank mine, Lake County; Bella Union or Rutherford mine, Napa County; Cloverdale mine, Sonoma County, and at the January mine, Yolo County. The Cloverdale is the only one of these mines at present (July, 1920) operating.

Production.

"Though some domestic yield of this metal is now obtained from Texas, Nevada, Arizona, and Oregon, the bulk of the output still comes from California.

The distribution of the 1919 product, by counties, was:

County	Flasks	Value
Lake	229	$20,604
Napa	644	58,140
San Benito	7,409	668,989
Santa Clara	3,012	271,762
Sonoma	1,418	119,142
Kern, Kings, San Luis Obispo, Siskiyou, Solano, Trinity, Yolo*	2,488	214,744
Totals	15,200	$1,353,381

"The outlook for 1920 promises a still lower yield of quicksilver. The New Idria mine in San Benito County, for some years the largest producer in the western hemisphere, is at present (July, 1920) shut down as the result of a fire which destroyed the tramway terminal, ore-bins, and electrical equipment necessary for the operation of their rotary kilns. They are rebuilding, and expect to have one furnace running on ore by September 1, and to add another each thirty days thereafter until all five are doing duty. Neither the New Almaden property nor the Guadalupe in Santa Clara County are producing, nor the Oat Hill mine in Napa County."

STRUCTURAL MATERIALS.

Brick and Tile.

Alameda, Contra Costa and San Joaquin are the largest producers of this class of material, in the district, followed by Sacramento, Fresno, and Santa Clara.

At practically all plants production in 1920 remained about normal.

*Combined to conceal output of a single operator in each.

Cement.

The district produces most of the cement manufactured in the state. Large plants are located at Davenport, Santa Cruz County; Cement, Solano County; Cowell, Contra Costa County; Napa Junction, Napa County, and a smaller plant at San Juan, in San Benito County. The production of these plants decreased in 1919, but the value of product increased. In a general way the several plants maintain quite steady production, the demand for cement being regulated by the amount of concrete construction work. Some of the plants have not been working to capacity and it is difficult to state whether the production for 1920 will be greater or less than for 1919. It is quite safe to say, however, that the production figures will not be greatly changed. The prospect for 1921 is for an increase in production, due principly to increase in highway construction.

Magnesite.

Magnesite is produced principally, in the Porterville district in Tulare County, the Napa and Sonoma counties district north of San Francisco Bay, and in Alameda, Santa Clara and San Benito counties.

Magnesite is a natural carbonate of magnesium, and when pure contains 52.4% Co_2 (carbon dioxide) and 47.6% MgO (magnesia). It has a hardness of 3.5 to 4.5, and specific gravity of 3 to 3.12. It is both harder and heavier than calcite (calcium carbonate), and also contains a higher percentage of CO_2, as calcite has but 44%.

Most of the California magnesite is comparatively pure, and is ordinarily a beautiful, white, fine-grained rock with a conchoidal fracture resembling a break in porcelain. The Grecian magnesite is largely of this character; while the Austrian varieties usually contain iron so that they become brown after calcining.

In California, the known deposits are mostly in the metamorphic rocks of the Coast Ranges and Sierra Nevada Mountains, being associated with serpentine areas.

The Washington deposits are stated to be associated with extensive strata of dolomitic limestones. The magnesite there appears to contain more iron than most of the California mineral, which makes it desirable for the steel operators. However, the experience of the past four years has proven that several California localities have sufficient iron in their magnesite to be serviceable in the steel furnaces.

It looks as if the main hope for the future for California magnesite lies in the development of the plastic business in the territory west of the Rocky Mountains; and in the manufacture of refractory brick to be utilized mainly by the copper and lead smelters in the same district. It is possible that, after ocean shipping has resumed its normal routes, California magnesite may be sent via the Panama Canal to the Atlantic seaboard; but, on account of our higher production costs, it is difficult to see how we can compete with the Grecian article at Atlantic ports.

Three new plants are making refractory brick here from California magnesite, one each at Porterville, Los Angeles, and Richmond. During 1917–1918, the output of the Refractory Magnesite Company at Preston, Sonoma County, was turned into bricks at the plant of the Stockton Fire and Enamel Brick Company, at Stockton, but the mine was closed in 1919. The mineral from this property is a natural ferro-magnesite

and has found a ready market for refractory purposes. That from the White Rock mines in Napa County also carries some iron.

Miscellaneous Stone.

Miscellaneous stone is the name used for that branch of the mineral industry covering crushed rock of all kinds, paving blocks, sand and gravel, and pebbles for grinding mills.

In 1920, as has been the case for a number of years past, Los Angeles led all other counties in the output of this material, but Alameda holds second place, followed by Sacramento, Contra Costa, and Fresno in the order named.

INDUSTRIAL MATERIALS.

These materials, many of which are mineral earths, are, with four or five exceptions, as yet produced on a comparatively small scale. The possibilities of development along several of these lines are large and with increasing transportation and other facilities, together with steadily growing demands, the future for this branch of the mineral industry in California is certainly promising. There is scarcely a county in the state but might contribute to the output.

Up to within the last few years, production has been in the majority of instances dependent upon more or less of a strictly local market.

The more important of these minerals thus far exploited, so far as shown by annual value of the output, are limestone, mineral water, pyrite, pottery clays, and diatomaceous earth.

SALINES.

Magnesium Salts.

Magnesium chloride is an important item in certain chemical uses, and in the preparation of Sorel cement in laying magnesite floors. Previous to 1915, Germany was the principal source of this chloride, which source has since, of course, been cut off. For this reason experiments have been made to prepare it by acid solution from magnesite, which is so abundant in California. Some of the salt companies began its commercial preparation in 1916, from the residual bitterns obtained during the evaporation of sea water for its sodium chloride.

In addition to the chloride, some magnesium sulphate, or 'technical epsom salts' was also made by the Oliver Chemical Company in Alameda County and the Whitney Chemical Company in San Mateo County. The Merle Magnesia Company at Redwood City, San Mateo County, produced magnesium carbonate.

Common Salt.

About 80% of the salt production in California comes from plants in Alameda and San Mateo counties where the waters of San Francisco Bay are evaporated. Output for 1920 remained at a normal figure.

OUTLOOK FOR 1921.

The mineral industry in the San Francisco district is so scattered and diversified that it is impossible to make any general statement as to the outlook for the coming year.

It is believed that the entire nation is entering upon a new era of industrial development. Crude substances which formerly came from

foreign countries are being sought at home. Manufacturers and large consumers are looking more and more to California and the west for sources of supply.

New factories, and branches of old established concerns are locating in the San Francisco Bay region and among them all there is a demand for almost every mineral substance on the list.

It would appear to be impossible to take other than an optimistic view of the future even in the face of "deflation" and prophesied hard times.

Mining as a whole is a basic industry. Its crude products are necessary to sustain life—as we know it and under conditions of living which we demand today. Minerals when dug from the ground represent new wealth—and in periods of depression such wealth should be particularly acceptable.

GEOLOGY.

Geography and Topography—Transportation Facilities, etc.

Unfortunately the State Mining Bureau has not been able to layout its field divisions with a great deal of regard for natural boundaries.

A limited amount of money is available to carry on the work and only a few men make up the engineering staff.

As a matter of administrative convenience and necessity the San Francisco division contains twenty-eight counties extending from the Pacific Ocean to the Nevada line—at one point—and from Glenn in north to Kings County in the south.

Geographically these counties fall into six groups which will be briefly discussed as follows:

I. North Coast Group.

(*San Francisco Bay north to Humboldt.*)

This region lies between the summit of the Coast Range and the Pacific Ocean, and is made up almost entirely of slates, cherts, limestones, sandstones and serpentines of Jurassic and Cretaceous ages.

Much of this territory is rough and rugged, and while there is a railroad from San Francisco to Eureka, the transportation facilities are not of the best, particularly as regards many of the mineralized sections which are accessible by wagon road only.

The climate is mild, with large annual rainfall. Power facilities are on the whole undeveloped and fuel (aside from wood) must be shipped in.

There are no particular outfitting and supply headquarters in the district, although in the southern portion there are several up-to-date and prosperous cities and towns.

Commercial minerals found here are quicksilver, manganese, magnesite, and others which would naturally be associated with rocks of sedimentary origin.

They will be discussed in detail under the "County" headings in Part II of this report.

II. South Coast Group.

(*San Francisco Bay south to San Luis Obispo.*)

This group of counties lies on the west of the Coast range of mountains, extending to the Pacific ocean. As in the case of group I the predominating rocks are of sedimentary origin although the formations are much more complex and broken than those along the north coast.

The mineral deposits, consisting of quicksilver, limestone, dolomite, barite and many others, lie in localities which as a rule are rugged and difficult of access. Climatic conditions are perfect, however, and the rainfall is not heavy. As previously mentioned, details relative to occurrence and distribution of minerals are given under the county chapters in Part II.

III. Bay Counties Group.

The counties surrounding San Francisco Bay produce a surprisingly large amount of minerals, and deposits of many which are not yet commercially utilized, have long been known to exist.

In the sedimentary formations of this section are found asbestos chromite, clay, coal, limestone, pyrite, etc., etc.

Transportation and power facilities are on every hand, markets are nearby, fuel and supplies are obtainable under the most favorable conditions.

IV. Sacramento Valley Group.

V. San Joaquin Valley Group.

The counties in groups IV and V cover the great interior valley region of the state most of which is covered with a mantle of recent alluvial deposits. However, almost without exception, the borders of these counties reach into the foothills of either the Coast Range on the west or the Sierra Nevada mountains on the east.

As mineralized areas are found at short intervals throughout both the above ranges, and as the valleys themselves contain deposits of clay and other mineral earths, petroleum, natural gas, etc., it is a fact that the counties under discussion produce, to some extent, practically every metal and mineral substance known in California.

No portion of this region is at a very great distance from a railroad; electric and other power is easily available, speaking in a broad way; and outfitting and supply centers are situated on every hand. Marysville, Sacramento, Stockton, Modesto, Merced, Madera, Fresno, Hanford, and Visalia are among the larger cities which dot the valley from north to south.

VI. Sierra Nevada Group.

The eastern portion of the San Francisco district is made up of Mono, Mariposa and portions of Madera, Fresno, and Tulare counties.

Most of this region is in the heart of the high Sierras and the geological formations consist entirely of granites and volcanic rocks of igneous origin.

The average elevation is very high and heavy snowfalls prohibit prospecting, or even traveling, in the winter months. This country

is extremely rough and rugged, and is handicapped by having no railroads and being difficult of access, in many portions, even by automobile or team.

Several power lines traverse this district, and wood and timber are plentiful. Supplies, equipment, etc., must, for the most part, be brought in from outside points.

Gold and silver mining is the principal industry.

Part II.

San Francisco District: By Counties.

ALAMEDA COUNTY.

By E. Huguenin and W. O. Castello.

The field work in this county was carried on by Emil Huguenin in 1917. Owing to lack of funds the report was not published at that time. Additional work was done by W. O. Castello in 1919 and information has also been obtained from reports furnished the Mining Bureau by operators. Data has also been drawn from recent bulletins on special subjects, namely Bulletin No. 76, Manganese and Chromium in California; Bulletin No. 78, Quicksilver Resources of California; and Bulletin No. 79, Magnesite in California (not yet printed).

Alameda County, created March 25, 1853, lies on the eastern or continental shore of San Francisco Bay, being bounded on the north, east and south by Contra Costa, San Joaquin, and Santa Clara counties, respectively. It has a land area of 732 square miles, 500 of which are rich agricultural bottom lands devoted to intensive farming and fruit growing. Its population is 344,177, about 75 per cent of which is grouped in the three principal cities, Oakland, Berkeley and Alameda, located on the bay shore.

Oakland, the county seat, has a population of 214,422. Its location as the natural point of transfer between land and water carriers for the great railroad systems that converge there, together with its large inner harbor has made it one of the important industrial centers of the Pacific Coast.

The county is traversed in a northwesterly and southeasterly direction by several mountain groups or ranges, which together form the eastern group of the Coast Range Mountains. These ranges become rugged and reach higher altitudes in the southeastern portion of the county, their continuation into Santa Clara County culminating in the Mount Hamilton Range. The mountains here comprise largely the metamorphic sandstones, jaspers, and serpentines of the Franciscan formation, in which occur the chrome, magnesite, and manganese deposits. This section is the most inaccessible in the county, being penetrated only by the dirt roads from Livermore, the nearest railroad station.

Alameda Creek, Arroyo del Valle, Arroyo Mocho and their tributaries form the principal drainage systems of the county. The former rises in the hills in Santa Clara County, flowing northward to Sunol, where it joins the latter, thence westward through the Niles Cañon, emptying into San Francisco Bay at Alvarado. The Arroyo del Valle rises in the extreme southeastern corner of the county flowing northwestward to Pleasanton, then almost due south to Sunol. The Arroyo Mocho parallels the Arroyo del Valle for the greater part of its length, being a few miles to the northeast.

MINERAL RESOURCES.

Although not classed as a mining county, Alameda produces a variety of minerals. These may be grouped according to their commercial importance and occurrence as follows: Crushed rock, sand, and gravel, combined in this report under the heading "Stone Industry," are produced mainly from the gravel beds of Alameda Creek and from the Franciscan sandstones in the hills bordering the bay. The production of salt by evaporating the bay waters along the East Shore ranks second in value of minerals produced. The manufacture of brick from the clay beds in the Livermore and Niles valleys ranks third. Pyrite is mined at Leona Heights, east of the city of Oakland. Chrome, magnesite, and manganese occur in the Franciscan areas in the southeastern portion of the county and their commercial exploitation was given a new impetus by the European war, due to the heavy demand for these minerals. Coal was mined for a number of years in Corral Hollow near the eastern boundary of the county, but no production has been recorded for the last fifteen years.

Asbestos, copper, limestone, mineral water and soapstone also occur in this county.

ASBESTOS.

A few tons of asbestos were mined on the hills east of Fruitvale, close to the Contra Costa County line, in 1915, by the John D. Hoff Asbestos Company, of Oakland. The fibre was short and the occurrence so limited that no further production has been made. It was ground and used with magnesite in the manufacture of fireproof tile at their plant.

BRICK AND CLAY.

The California Brick Company, established in 1909, operates a brick yard 1½ miles west of Niles between the main lines of the Western Pacific Railroad. The clay is obtained from a superficial deposit 20 feet thick, which covers many acres. It was formerly excavated by plowing and scraping, using teams, but a drag scraper, electrically operated, has been in use for the last two years.

The clay is conveyed to 3 dry pans, 2 stiff mud machines, 1 dry press and 4 repress machines. The bricks are then dried in waste heat driers, which utilize the waste heat from the kilns. This is accomplished by means of a large central tunnel, equipped with blowers, which runs between the two kilns, and connects with the brick drying chambers. The bricks are then burned in two Haigh continuous kilns, each 600 feet long and contains 42 chambers, total 84 chambers. The capacity of each chamber is 10,000 bricks, and the output of the plant is about 40,000 bricks daily. An interesting feature of the plant is a large traveling overhead electric crane which was formerly used for transporting the bricks to and from the kilns, but which is now used only for loading.

The entire plant is under one roof and the machinery is operated by electric power supplied by the Pacific Gas and Electric Company. There is a transforming station at the plant. Crude oil is used for the kilns.

Besides the dark red paving brick the company now manufactures sewer brick, common brick, paving fiber, partition tile, hollow building blocks and other products.

N. A. Dickey is president and A. C. Meyers is superintendent.

This company also operates the Livermore Fire Brick Works, at Livermore, described hereafter under that heading.

The California Pottery Company, established in 1872, operates a pottery at East Twelfth street and Polk avenue, Oakland. Most of the clay used is obtained from Amador and Calaveras counties, but the loam used for a filler is obtained from trenches excavated for street work about Oakland and South San Francisco. The company manufactures vitrified sewer pipe, chimney pipe, drain tile, flue lining, various terra cotta products and garden pottery. In the latter part of 1918 a lead pot machine was installed, the company having a contract with W. P. Fuller and Company for 100,000 of these pots, and also a contract with the National Lead Company for 25,000. The machine has a capacity of 6000 per 8 hours. The main equipment consists of 8 downdraught kilns, 1 sewer pipe press, 1 auger brick machine and repress, 3 dry pans and 2 wet pans.

A 110 horsepower steam engine supplies the power and the boilers are capable of generating 200 horsepower. Crude oil is used for fuel. About forty men are employed throughout the year. F. A. Castello is president and Franc. C. Aruda is superintendent at the plant.

California Pressed Brick Company operated, during a short period, a yard in the Niles Cañon, 1 mile northeast of Niles. The plant was equipped with downdraught kilns and is now partially dismantled. There is no prospect of its being reopened as the company is defunct.

N. Clark and Sons, Pottery. The pottery is at Pacific avenue and Fourth street, Alameda, and has been in operation over thirty-two years. Part of the plant was destroyed by fire in July, 1917, and the company was not allowed by the government to rebuild, the industry being classed as nonessential. It is now (May, 1919) being rebuilt and the plant will soon be operating at its old time capacity.

The highgrade clays are obtained from the company's pits in Amador County and a calcareous shale was previously quarried from a bank near Walnut Creek, Contra Costa County. The latter material was used as a filler and has not been utilized since the fire.

An average of 25 men were employed during the last year, but when running to capacity the plant will employ from 125 to 150 men.

Clay is hauled to the pressers by elevators and the various products are hauled by electric trucks. The material will be dried in 2 steam heated driers, and burned in 17 downdraught and muffle kilns. There are dry and wet pans, sewer pipe, and brick presser, etc. A 500 horsepower Corliss steam engine operated the plant. Crude oil is used for fuel.

The products are pressed brick, fire brick, sewer pipe, terra cotta, etc. Several of Oakland's largest buildings are faced with architectural terra cotta made at this plant, among which may be mentioned the Capwell Building, Federal Realty Building, and the T. and D. Theatre. Albert V. Clark is president and Geo. Q. Clark, secretary; main office, 116 Natoma street, San Francisco.

The **Livermore Firebrick Works.** This plant, located at Livermore, was originally built to burn magnesite. For many years, from 1910 until the latter part of 1918, it was operated by the Livermore Firebrick Company, F. A. Bishop, president. It is now under the management of the California Brick Company, who also operates a large plant west of Niles.

All the clay used is obtained from Amador and Placer counties. The equipment consists of 6 downdraught kilns, two 30-foot and four 26-foot, 2 square muffle kilns, 2 round muffle kilns just completed (May, 1919), 1 American repress machine, capacity 25,000, 1 auger machine capacity 25,000, and 1 dry press capacity 20,000. The products were formerly dried in steam heated driers which utilize the waste heat from the kilns.

Crude oil is used for fuel and electric power operates the plant. An average of 50 men are employed throughout the year. The products are fine brick, pressed brick, enamel brick and terra cotta. N. A. Dickey is president, A. C. Meyers, superintendent, and Will Hyslof, yard superintendent.

The **Remillard Brick Yard,** located 1½ miles northeast of Pleasanton on the main line of the Southern Pacific Railroad, was established in 1889 and has been operated continuously since. Only common red bricks are manufactured. The material is obtained from a superficial deposit of sandy loam 25 feet thick, by means of a drag line scraper operated by an electric hoist. The loam is loaded into cars and hauled by motor one-fourth mile to the yard, where it is passed through wet pans and soft mud machines. The bricks are dried in yard and burned in 2-16 compartment Hoffman kilns, of 20,000 daily capacity each. Fifty men are employed during the season. C. Remillard is president and F. W. Miller, secretary; home office, First and Clay streets, Oakland.

Bibl.: Repts XII, p. 381; XIII, p. 613. Bull. 38, p. 242.

CHROMITE.

Chromite occurs in the southeastern portion of the county in the serpentine areas which are common to the Franciscan group. The only important deposits known are those which occur on Cedar Mountain and which were first mined years ago. It is reported that over 6500 tons had been mined from this locality, up to the time of the break in the market at the end of 1918.

Clark Claim, Vernon Clark, Livermore, owner. This claim is on section 26, T. 4 S., R. 3 E., M. D. M., just east of the Newman mine. It is worked through an incline shaft and some ore was shipped in 1916 by the Noble Electric Steel Company under a lease. It is stated that there is an ore body of considerable size, but water was encountered which made operation difficult.

Bibl.: Bull. 76, p.115

Mendenhall Mine, situated near the old Newman Mine, operated by H. Towhey and Wiggin, and credited with a total production of about 3000 tons. When visited (May, 1919) the mine had not been in operation for the past few months but the operators had just completed the construction of a dry concentrating plant with which it is

planned to treat the low grade ore on the dump. This ore was from 8% to 32% Cr_2O_3 and it is believed the concentrate will run from 45% to 52% Cr_2O_3. The plant will handle about 60 tons of ore per day and will produce about 8 tons of concentrate. The equipment consists of a Herman ball mill, Stebbins dry concentration, 4 gasoline engines, pump, etc. It is planned to install a wet concentrator table later, if the market warrants. There are several thousand tons of low grade ore on the dump and considerable ore was shipped during the latter part of 1917 and the first part of 1918. Very little work has been done during the last few months, only one man being kept at work at the mine to hold the lease. About 25 tons of ore are on hand at Livermore and a few tons at the mine. The total production from this mine is said to be over 3500 tons. S. V. Newman of Livermore is owner.

Bibl.: Repts. XII, p. 36; XIII p. 48. Bull. 38, p. 267; Bull. 76, p. 115. U. S. G. S. Bull. 430, p. 173.

Newman Mine, formerly known as the **Mendenhall Mine,** lies about 15 miles by road southeast of Livermore in section 26, T. 4 S., R. 3 E. E. C. Harder* in his description of this property writes as follows: "The ore occurs in irregular lenticular pockets and stringers in more or less decomposed serpentine. Where the serpentine is much decomposed it is soft and broken and has a brown stain. The chorme ore that occurs in this rock is generally soft and friable and a dull grayish-black color, but that in the fresh serpentine is glossy black in color and contains very little intermixed serpentine. Some masses of fairly compact ore are found within pockets of soft ore, as if they were not yet thoroughly disintegrated."

Development consists of several open cuts, and tunnels, totaling about 800 feet in length. The larger lenses or pockets appear to have been exhausted. Considerable work has been done here by the Noble Electric Steel Company during 1916. They mined and shipped several hundred tons to their smelters at Heroult. For the last two years it has been, and is at present (May, 1919) under lease to J. W. Clark and D. McDonald, Livermore, and considerable ore was shipped during the latter part of 1917 and the first part of 1918. Very little work has been done during the last few months, only one man being kept at work at the mine to hold the lease. About 25 tons of ore are on hand at Livermore and a few tons at the mine. The total production from this mine is said to be over 3500 tons. S. V. Newman of Livermore is owner.

Bibl.: Repts. VII, p. 36; XII, p. 48. Bull. 38, p. 267; Bull. 76, p. 115. U. S. G. S. Bull. 430, pp. 173-174.

COAL.

Coal was discovered in Corral Hollow in 1862, and shortly afterwards a few mines were opened up. However, a comparatively small production was made until 1897. Operations in this field ceased entirely in 1902, because of the inferior quality of the coal, which made its competition with outside coal impossible, as well as the high cost of extraction due to the steep dip and faulted nature of the beds.

*U. S. G. S. Bull. 430, pp. 173–174.

The **Beckman-Linden Engineering Corporation,** 593 Market street, San Francisco, have (June, 1919) purchased the Tesla property and begun the erection of buildings and equipment for mining and grinding the coal. It is intended to produce a powdered product which will be used as fuel for boilers, and which will be fed into the fire boxes by air blasts, similar to crude oil. This method has proved satisfactory in other localities. It may be used at the property for the production of electric power. Extensive operations are planned, so that the near future may witness the return of the old time activities in this district.

The Corral Hollow field was visited and described in detail by George Otis Smith in his report on "The Coal Fields of the Pacific Coast,"* from which the following brief extract is quoted:

"The Mount Diablo and Corral Hollow fields are in rocks of Eocene (Tejon) age . . . The Tejon formation consists of light-colored sandstones and associated shales and probably measures about 1000 feet in thickness . . . In Corral Hollow the rocks are much the same as on the north side of Mount Diablo, but here the faulting is more extensive and the dips of the coal beds much higher, being from 30° to 80°.

"There are a number of seams but the productive ones are the Eureka and the Summit. The Eureka has been developed to a considerable extent and is 10 to 12 feet in thickness. The roof is solid sandstone, but the floor is less satisfactory. The Summit seam averages 7 feet of clean coal and has an excellent floor of hard sandstone, but the roof is slate, which from its shaly character involves expense in timbering . . .

"The Tesla coal, as tested at the Union Iron Works in San Francisco, was found to be uniform quality, burning freely, with an ash percentage of between 8 and 9 per cent, with comparatively few clinkers. The following analysis of the Corral Hollow lignite, by R. C. Hilk, may be considered as typical for the best grade of California coal.

Moisture	10.80%
Volatile combustibles	43.10%
Fixed carbon	38.57%
Ash	7.53%
	100.00%

Bibl.: Repts. X, p. 91,; XII, p. 39; XIII, p. 51. U. S. G. S. 22d Annual Report, Part III, pp. 501-504.

LIME AND LIMESTONE.

Pleasanton Lime and Cement Company. This company has a lease on a limestone deposit that is situated half way between Sunol and Pleasanton on the Western Pacific Railroad. Very little development has been done on the deposit only occasionally a few tons being burned and distribution for fertilizing purposes. The stone is burned in 2 patent kilns equipped with oil burners. For the past few years just enough work has been done on the property to hold the lease. Philip Kolb, of Pleasanton is president.

*U. S. G. S. 22d Annual Report, Part III, pp. 501–504.

McLaughlin Company's Lithographic Stone Quarry* is in the SW. ¼ of the SW. ¼ of the SE. ¼ of section 35, T. 1 S., R. 2 W., M. D. B. and M., close to the Contra Costa County line. The property consists of 8 acres. The stone from the croppings is found to be quite hard but not homogenous as it contains silica in quantities sufficient to be a detriment for lithographic work. The croppings which are about 570 feet in length, run slightly south of east and north of west and dip southerly 75 degrees. The walls are of sandstone and conglomerate.

The vein is about 5 feet thick and has been opened by a 30′ open cut which was made about 15 years ago by J. Ramage. This cut has uncovered the vein for a distance of about 25 feet along the strike and 20 feet high. Considerable stone from this cut is to be seen on the dump.

That part of the vein that has been exposed to the elements seems to have been hardened and bleached and is very light grey in color. The stone seems to have some very small fractures but they are not harmful. The stone that is available at the present time has some of the properties of a good lithographic stone such as taking grease, oil and ink, and being acted upon by acids, but it has not quite the fineness and uniformity of grain required for engraving work. As is shown, however, by the results of a practical test made by Schmidt Lithographic Company, it could be used for "penning", that is, for painting the design upon the surface of the stone instead of cutting the design into the stone. The character of the stone in depth can only be determined by doing development work. The property is idle.

MAGNESITE.

Magnesite was mined in Alameda County as early as 1886, the deposits being located on Cedar Mountain about 13 miles southeast of Livermore. The magnesite occurs in a decomposed serpentine rock and is a yellow clay in which are imbedded large boulders. It lies in pockets and small veins, the latter running in all directions. Magnesite croppings and considerable float have been found in Rock Ridge west of Cedar Mountain and separated from it by the Arroyo del Valle, but no large deposits have yet been uncovered.

Bibl.: U. S. G. S. Min. Resources, 1886, p. 696.

The Cedar Mountain Magnesite Mine, located in section 27, T. 4 S, R. SE., M. D. B. and M., about 14 miles southeast of Livermore at an elevation of 3250 feet. It has, since 1917, been under lease to J. W. Clark and D. M. McDonald of Livermore. Previous to this, since January, 1915, it was under lease to Clark and Wente.

Over 2000 tons of magnesite were shipped from this deposit in 1916 and about 1160 tons were sold to John D. Hoff Asbestos Company in 1917. This latter brought from $12 to $14 per ton. Very little work has been done since 1917. About a car load of ore is at present on hand (May, 1919). The magnesite from this deposit is, as a rule, of excellent quality.

There are a series of small magnesite outcrops running east of north and dipping eastward. Wherever these croppings have been uncovered or dug into they show up as tops of lenses which widen

*From an unpublished report by W. W. Bradley.

out below the surface. The largest lens was developed by a glory hole and cut. A tunnel driven 10 feet below the bottom connected with a chute, through which the ore was hauled. Work was also done on several croppings to the north of the glory hole.

There is an oil burning flat hearth type furnace at the property which was built by Mr. Swindell who worked the mine in 1914. It has now been partially dismantled. The furnace was designed especially to produce a "deadburned" magnesite and had a capacity of 5 tons of calcined material per 24 hours. It is said to have produced a very uniform burn, but its cost of operation was higher than that of shaft furnaces, as it required more labor to operate and its fuel consumption was greater per tons of magnesite calcined. Water for the camp is obtained from a well on the property.

M. C. Crocker, 1023 Insurance Exchange Building, San Francisco, is the owner.

Hayes Ranch Deposit. Some small croppings of buff colored magnesite occur in the SW. $\frac{1}{4}$ of section 24, T. 4 S., R. 2 E., about 11 miles southeast of Livermore near the summit of Rocky Ridge. Some large boulders of pure white float were found in a ravine north of and below the outcrop. Several tunnels were driven into the hill under these boulders in hopes of striking an ore body but none was encountered. On the east slope of the ridge numerous boulders have been found. Cuts have been made along the slope at several places in all of which boulders of high grade ore have been found. It is very possible that these boulders are in place being formed as a gradual replacement of serpentine, however, considerable development is necessary to fully determine this. There has been no rock shipped from this prospect and it is idle. An old wagon road from Livermore gives easy access to the property which is under lease to E. P. Newhall of Livermore.

MANGANESE.

The manganese deposits of Alameda County are confined to the region southeast of Livermore, in what is known as the Tesla Quadrangle of the U. S. Geological Survey. They occur as interbedded lenses in jaspers of the Franciscan formation varying in extent and thickness as well as character. In places the ore is deposited as the porous black oxide, but often merely as stains and partial replacements along cracks in the jasper.

A few of the deposits were worked in the eighties and occasional mining has been done since then. In 1917 and the first part of 1918 under the stimulus of war conditions considerable ore was shipped from this district and several new properties were opened.

John Berendiere Mine. In section 14, T. 4 S., R. 3 E., 12 miles southeast of Livermore on the ridge northeast of the Arroyo Mocho at an elevation of 1750 feet. On the surface there is a large outcrop of jasper heavily stained with manganese. Several open cuts have been made, the largest of which is about 10 feet deep and 10 to 12 feet in diameter, from which considerable ore was taken, and at the bottom of which is exposed a ledge of good ore. About 40 feet below this a tunnel was driven, from which some fairly good ore was taken. This tunnel was continued for some fifty feet, but failed to strike the main ore body in

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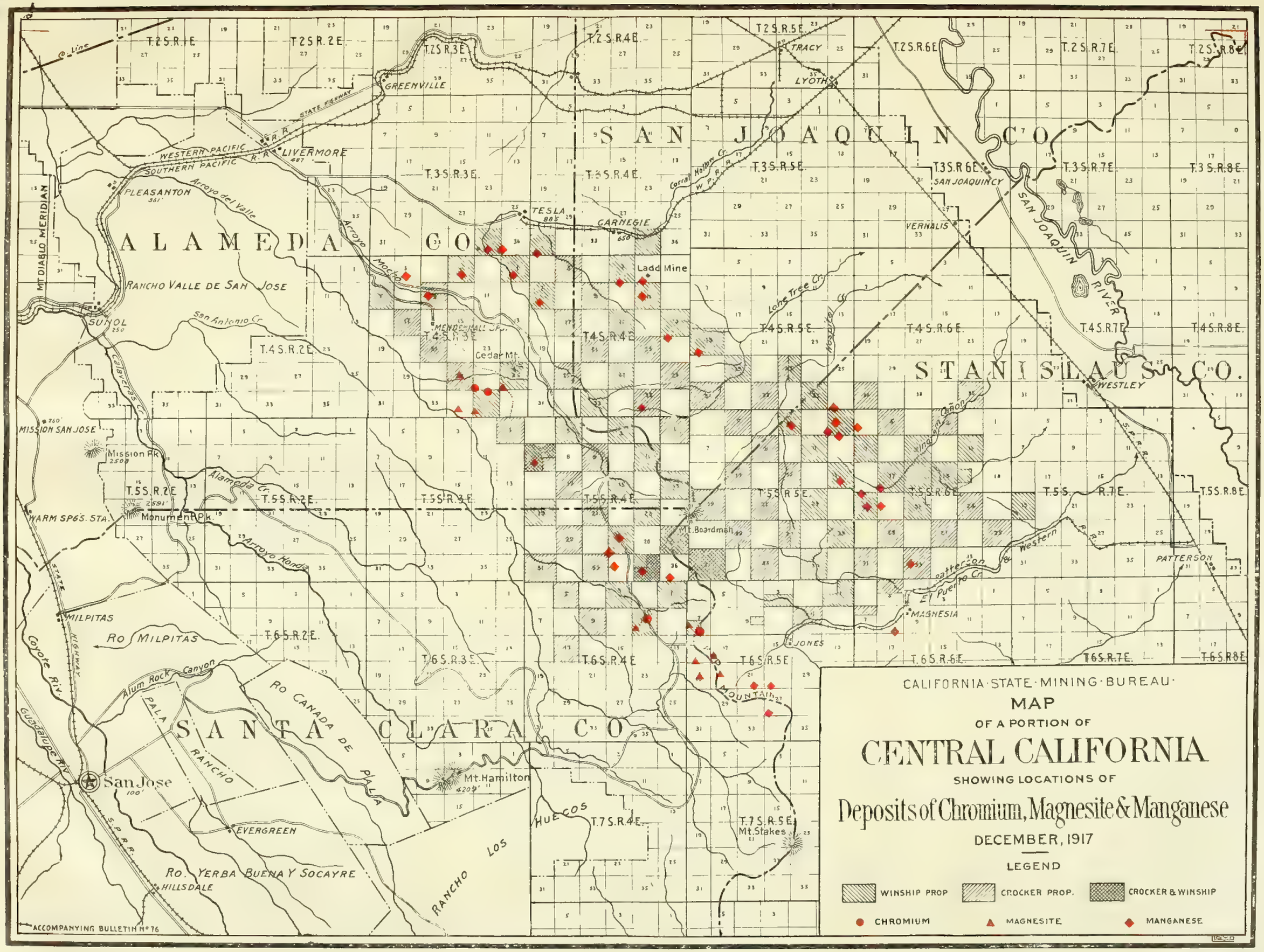

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Plate I. Map of a portion of Central California, showing deposits of chronium, magnesite and manganese.

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the cut mentioned above, as it appears to be driven too low and too far to one side. A car load, about 50 tons, of ore was shipped in 1917 and 1918 by Mr. Young on a royalty basis and there is at present (May, 1919) about 15 tons of ore at the mine. The ore was hauled down the side of the hill on a sled and dumped into a small bunker, from which it was loaded directly into a truck. Has not been worked for several months. The ore is a porous black oxide, associated with the jasper and shale of the Franciscan series. The general strike of the bed is north and south and the dip 50° to the east. John Berendiere of Livermore is owner.

Bibl.: Bull. 76, p. 25.

Black Jack Mine is in the same section as the above Berendiere Mine, adjoining it on the southeast. It was first opened in 1885 and some small shipments made. This deposit is described by E. C. Harder as follows: "The country rock is jasper, thin layered and separated by seams of shale. The jasper layers differ in thickness from a fraction of an inch to several feet. The same layer varies in thickness, pinching out locally in many places. Most of the shale seams are thin. Both shale and jasper are greenish gray, except where stained red or black by iron or manganese.

"The ore occurs in several interbedded lenses or pockets a few feet thick and of small extent. It is soft, friable black oxide contained in cavities between numerous intersecting quartz seams, or as seams intersecting jasper fragments. Most of the quartz seams are later infiltrations, but the fragments are residual from jasper, which the ore has replaced. The seams are generally vitreous and the fragments earthy. In some places yellow decomposed jasper fragments have been largely replaced by manganese oxide; elsewhere only a surface layer is replaced. The deposits commonly have a footwall that is thin bedded and more shaly than the hanging wall."

Development consists of a 50-foot tunnel and several small cuts.

There are several small croppings on this property southeast of and below the Black Jack. A couple of shallow trenches expose a small deposit below the road. About a carload of ore was shipped from this deposit in 1917-1918 and there are several tons at the mine. It was idle (May, 1919) at the time visited. H. T. Overacker, Livermore, is the owner.

Bibl.: Bull. 38, p. 335; Bull. 76, p. 25. U. S. G. S. Bull. 427, pp. 161-162.

Buckhorn Claim. Chas. J. Jansen of Livermore has a claim in section 31, T. 4 S., R 3 E., about 16 miles southeast of Livermore, on the Arroyo Mocho. A few shallow cuts have been made on a prominently outcropping jasper ledge, which can be traced for 300 feet along the surface. The strike is approximately north and south. Some high grade ore was exposed and a few tons were shipped in the latter part of 1917. No recent operations (May, 1919).

Bibl.: Bull. 76, p. 25.

Camp No. 9, formerly known as the **Merchant Mine,** is 9 miles southeast of Livermore on the Arroyo Mocho road, in the NW. $\frac{1}{4}$ of section 9, T. 4 D., R. 3 E. It was opened in 1888 and has been worked

intermittently since. It has been under lease for several years to James J. Cummings of Livermore, and was subleased in 1916 to F. M. Doak, who took out about 50 tons of ore and then ceased work. Development work was later carried on by Cummings and over 1,000 tons of ore was shipped up to first part of 1918. It has been idle for some months past (May, 1919).

The vein varies from 6″ to 39″ in width, strikes approximately 10° north of west and dips 45° to 60° W. The ore consists of both the black oxide and steel gray carbonate. This is the only occurrence of rhodochrosite found in Alameda County, one other noteworthy occurrence in the State being that of the Ladd mine in San Joaquin County.

Development consists of two tunnels; the upper one about 5 feet above the level of the county road is in about 100 feet, and the second one, some 30 to 40 feet lower, is in about 150 feet. The upper tunnel follows the vein part way, but no ore was taken out except that broken in the course of driving. Stoping has been done above the lower tunnel and some good ore taken out.

M. I. Crocker, 354 Pine street, San Francisco, is the owner.

Bibl.: Repts. XII, p. 329; XIII, p. 506. Bull. 38, p. 335; Bull. 76, p. 26.

Crosby Prospects. Situated in SE. ¼ of SW. ¼ of section 30, T. 4 S., R. 3 E., one-half mile by trail from the Crosby Ranch, which lies 12 miles from Livermore. Owned by the Wm. Crosby Estate. On the northerly prospect a large block containing about 50 tons of siliceous ore is exposed on the surface. On the other prospect, about 500 feet south of the first, there is a bed of massive chert three feet thick, containing a few pockets of manganese oxide. The northerly prospect promises to develop ore.

Dewhirst Mine, Mrs. Amanda Dewhirst, Livermore, owner. McDonald and Clark of Oakland, lessees. Lies 12 miles southeast of Livermore in NE. ¼ of SW. ¼ of section 22, T. 4 S., R. 3 E., and is reached by the Cedar Mountain road. A lenticular body of massive manganese oxide ore striking east and dipping 50° south, in radiolarian chert, has been exposed in an open cut and a drift. From the drift ore was stoped nearly to the surface. Some ore was shipped 1917-1918 which ran 34% Mn., and high in silica.

Elliott and Searles, of Oakland, in the latter part of 1917 opened new workings on the south slope of Man Ridge, 20 miles southeast of Livermore, on or near section 7, T. 5 S., R. 4 E. Several hundred tons of ore were shipped from this deposit. The ore body is from 10′ to 12′ thick, but its relation to the surrounding cherts is obscured.

Ellis Ranch Deposit. A small vein of manganese ore has been exposed by an open cut on the ranch of Edward T. Ellis, 8 miles southeast of Livermore on the Tesla road, in section 28, T. 3 S., R. 3 E. First discovered over 30 years ago. Two small cuts, about 10 feet apart, have been made on the vein, which outcrops near the bottom of a gulch one-fourth mile south of the road. The ore is hard and blue black in color, a replacement in the jasper beds in which it occurs. Where exposed it was about 18″ in width. Several tons of ore running 42% or 43% were shipped during the recent activities. Property is idle at present (May, 1919).

R. Friggel Prospect is in the NW. $\frac{1}{4}$ of section 22, T. 4 S., R 3 E., near the Dewhirst mine. Several blocks of siliceous manganese oxide lie in the soil on this claim. The relation to the country rock is not clear, but the manganese is thought to be landslide material. No commercial ore was seen here and no ore has been shipped.

Kelly Ranch Deposit. Located in section 5, T. 4 S., R. 3 E., 8 miles southeast of Livermore and one mile north of the Arroyo Mocho road, at an elevation of 1450 feet. There are two bodies of massive oxide ore here, the northerly one varying from 5 to 7 feet in thickness and separated from the southerly one by a body of barren jasper 6 feet thick. This property was until recently under lease to Holbrook and McGuire of San Francisco, who spent several thousand dollars in prospecting and development. It is said that there are from 3000 to 4000 tons of ore blocked out, but it is low grade and siliceous. Now under sublease to a Mr. Springer. Mrs. Kelly of Livermore is the owner.

Newhall Manganese Lease, sometimes called the **Bailey Mine,** is 10 miles southeast of Livermore in the SW. $\frac{1}{4}$ of NW. $\frac{1}{4}$ of section 10, T. 4 S., R. 3 E., on the east side of the Arroyo Mocho at an elevation of 2200 feet above the sea level. There is said to be a well defined vein of manganese ore in jasper from 1 foot to 4 feet in width.

The property was subleased to C. F. Wente in the summer of 1917 and several hundred tons of ore were later shipped. Idle May, 1919.

Newman Manganese Mine, formerly known as the **Estacia** or **Fratis Mine,** is on Cedar Mountain 18 miles southeast of Livermore in section 22, T. 4 S., R. 3 E. This deposit has been worked at long intervals in a small way since 1880. Interbedded lenses of manganese occur in jasper. The croppings have a strike of N. 30° W., dipping about 25° to the southeast. Development consists of a number of shallow cuts, which exposed an ore body varying up to 8′ in width. The ore is a soft friable black oxide contained in cavities between numerous intersecting quartz seams.

Leased to Clark and McDonald in September, 1917, who since that time took out about 14 tons of 49% ore. Idle May, 1919.

Reay Deposit, W. R. Reay, 2153 Lake street, San Francisco, owner, is in section 36, T. 3 S., R. 3 E., M. D. M. On a line between section 35 and section 36 there are croppings of rather good-looking manganese ore. About 300 yards or so east of the above-mentioned occurrence near the top of the ridge and well within the boundaries of section 36, is a large outcrop of chert, mixed with the black oxide of manganese. Undeveloped. An old wagon road, which could be put in repair for a nominal sum, passes nearby via Mitchell Ravine to Corral Hollow near Carnegie, a distance of 2$\frac{1}{2}$ miles. Other occurrences of manganese reported from this section also.

J. W. Root, Livermore, produced several carloads of manganese ore, in the first part of 1918, from a claim which he located on Man Ridge, in either section 7 or 18, T. 5 S., R. 4 E.

Scott and Winegar Mine, sometimes known as the **Man Ridge Mine,** comprises two claims owned by Chas. Scott and P. S. Winegar of Livermore. Reached by 2$\frac{1}{2}$ miles of rough road connecting with the

Arroyo Mocho Road, at a point 20 miles southeast of Livermore. The mine is near the summit on the south slope of Man Ridge in unsurveyed land, which would be in section 7, T. 5 S., R. 4 E. On the south side of a small knob there are some caved workings from which the Noble Electric Steel Company produced 600 tons of ore in the spring of 1917. The elevations of the different workings vary and it is not clear if all the exposed ore is in the same or in different horizons; some faulting is seen, however. In one working two distinct horizons of ore occur, separated by a few feet of barren, thin-bedded chert.

The **Standard Magnesite Company** owns a manganese property on Man Ridge, 20 miles southeast of Livermore, in section 7, T. 5 S., R. 4 E. Considerable production was made from this property during 1918, but operations were discontinued in November, 1918. The ore was hauled to Livermore and shipped. There is a 75-foot tunnel, with several cross cuts. An average of five men were employed. H. C. Haecke is president; home office, 244 California street, San Francisco.

Winegar Manganese Mine is 90 miles southeast of Livermore in the ridge east of the Arroyo Mocho alongside of the Camp Bessie Road, in section 4, T. 5 S., R. 4 E. The development consists of a short tunnel which is said to cut a lense of manganese ore. Very little work has been done at this property in recent years. H. V. Winegar of Livermore is the owner.

Winship Properties, K. D. Winship, 350 Post street, San Francisco, owner. In Alameda County, near Tesla, these properties include the following sections (see map, Plate I) which have manganese prospects or workings: Section 35, T. 3 S., R. 3 E.; sections 1 and 3, T. 4 S., R. 3 E.; section 31, T. 3 S., R. 4 S., M. D. M., leased to Joseph P. Donovan, Livermore. Some indications of manganese have also been noted on section 7, T. 4 S., R. 4 E., and on section 7, T. 5 S., R. 4 E., Donovan reports (December 10, 1917) that on section 31, above noted, he has driven a 250-foot crosscut, and is now in a body of ore of good grade showing at least six feet in width.

MINERAL PAINT.

There is a deposit of red chert on the property of John Berendiere, 12 miles southeast of Livermore on the Arroyo Mocho Road. This is in section 14, T. 4 S., R 3 E., and only about 100 feet from the manganese deposit of the same owner, described above. A sample of this rock was submitted to the Paraffine Paint Company's factory at Oakland, and experiments were made (May, 1919). It was found to have properties of sufficient value to warrant further investigation. A rock similar in color and properties, used in the manufacture of linoleum, has been obtained for years by the above company from Pennsylvania.

The deposit appears, on the surface, to be of considerable extent, as outcrops were noted at several places on the hillside.

The rock is dark red in color, highly stratified, quite uniform in quality and color, and has a greasy, schistose appearance on some of the cleavage faces.

MINERAL SPRINGS.

Although there has been no commercial production of mineral water in Alameda County there are several groups of mineral springs, the

waters of which are mostly used for domestic purposes. At the largest of these, Piedmont Springs, a recreation park has been conducted for a number of years.

The following descriptions of the Alameda County Springs are quoted from a report of Gerald A. Waring,* who made an exhaustive study on the springs of California.

"**Mayhew Spring** is about 200 yards north of Niles depot. It is situated in an orange orchard and is surrounded by a cement stone curbing which forms a reservoir about 4 feet in diameter and 10 feet deep. A small pipe and faucet furnish an outlet from a point about 3 feet below the surface, but the yield is only about 1 gallon a minute of water that had an observed temperature of 67° in the reservoir.

"The spring was known to the Spaniards in the early days and is still used to slight extent for drinking. Bubbles of gas continually rise in the reservoir, but the water is only faintly sulphureted. The spring is situated on a gentle alluvial slope at the mouth of a drainage wash, between hills of sedimentary rocks that are probably of Tertiary age.

"**Mendenhall Springs** are 11 miles by road southeast of Livermore on the steep southwestern side of the cañon of Arroyo Mocho, 500 feet above the stream. Two springs here seep from short prospect tunnels 50 yards apart that were driven many years ago in search of gold. The water was early noticed to be perceptibly mineralized, the perceptible taste apaprently being due to magnesia, and a number of years ago it was bottled as Aqua de Vida (Water of Life) Springs Water.

"The water of the southern spring is piped to a tank and furnishes a domestic supply: the other spring supplies a watering trough in the barnyard. Their flows are respectively one gallon and half a gallon a minute.

*U. S. G. S. Water Supply Paper 338.

"The following analyses show that they are essentially primary saline and secondary alkaline waters, the upper spring having the higher salinity:

Analyses of Water from Mendenhall Springs, Alameda County, California.
(Constituents in parts per million.)

	1		2		3	
Temperature					14° C. (58° F.)	
Property of reaction:						
Primary salinity		35		31		42
Secondary salinity						18
Tertiary salinity						
Primary alkalinity		8		1		
Secondary alkalinity		57		68		40
Tertiary alkalinity		54		?		32
Constituents	By weight	Reacting values	By weight	Reacting values	By weight	Reacting values
Sodium (Na)	136	5.91	96	4.16	148	6.43
Potassium (K)	5.5	.14			Trace	Trace
Calcium (Ca)	95	4.72	106	5.30	104	5.17
Magnesium (Mg)	41	3.36	44	3.61	46	3.77
Aluminum (Al)	3.3	.37			3.6	.40
Manganese (Mn)					Trace	Trace
Sulphate (SO_2)	178	3.70	144	3.00	374	7.78
Chloride (Ci)	42	1.18	38	1.08	52	1.48
Carbonate (CO_3)	278	9.25	270	8.99	183	6.11
Silica (Si_2)	7.2	.24	7.2	.24	9.4	.32
	786.0		705.2		920.0	
Carbon dioxide (CO_2)	164	7.45	Present	Present	79	3.58
Hydrogen sulphide (H_2S)					18	1.06

1. Lower Spring; analyst and authority, Winslow Anderson (1888).
2. Lower Spring; analyst, Falkenau and Reese, authority, 8th Cal.
3. Upper Spring; analyst and authority, Winslow Anderson (1889).

"The water is apparently of surface origin and has become somewhat mineralized from the materials through which it percolates. The tunnels are driven into thin-bedded cherts and crushed shales that belong to the Franciscan group.

"The property was improved as a mountain resort. In 1909 accommodations for 75 people were provided by several cottages and by a dining room in the main building. It has not been in operation as a resort for a number of years (June, 1919).

"**Piedmont Springs** are in a recreation park on the hillside 3 miles north of Oakland.

"Two mineralized springs, which are known, respectively, as Sulphur and Magnesia springs, rise in a ravine that extends through the property. The springs have been curbed and covered, and the ravine has been graded for a walk. The waters are piped about 100 yards downstream into two drinking basins in a grotto-like spring house that is built against a rock face at the side of the ravine. A third basin in the spring house is supplied from the municipal water main. The water of both springs is noticeably sulphureted, and that of the Magnesia Spring also tastes distinctly alkaline. The following analyses show the characters of the waters. Both have noteworthy primary salinity and secondary alkalinity, but although the sulphur spring is characterized by secondary salinity, the magnesia spring has high primary salinity.

Analyses of Water from Piedmont Springs, Alameda County, California.
(Analyst and authority, Winslow Anderson, 1889; constituents are in parts per million.)

	Sulphur spring		Magnesia spring	
Temperature	16°C. (60°F.)		14°C. (58°F.)	
Properties of reaction:				
Primary salinity		42		23
Secondary salinity		15		
Tertiary salinity				
Primary alkalinity				36
Secondary alkalinity		43		41
Tertiary alkalinity		29		59
Constituents	By weight	Reacting values	By weight	Reacting values
Sodium (Na)	151	6.55	113	4.93
Potassium (K)	7.4	.19	31	.78
Calcium (Ca)	58	2.92	23	1.13
Magnesium (Mg)	77	6.35	35	2.88
Iron (Fe)	Trace	Trace	14	.51
Aluminum (Al)	Trace	Trace	4.1	.45
Sulphate (SO_4)	329	6.84	33	.69
Chloride (Cl)	82	2.32	53	1.49
Iodide (I)	Trace	Trace	Trace	Trace
Carbonate (CO_3)	196	6.53	215	7.16
Metaborate (BO_2) a	14	.32	38	.89
Silica (SiO_2) b	87	2.87	72	2.38
	1,001.4		631.1	
Carbon dioxide (CO_2)	39	1.78	62	2.80
Hydrogen sulphide (H_2S)	61	3.58	Trace	Trace

a Reported as "borates," recalculated from $Na_2B_4O_7$.
b Reported as "silicates," assumed to be SiO_2.
The second analysis is given by Anderson[1] as from an "iron spring," but this is believed to be the same spring that is now known as the Magnesia Spring.

"**Sweet Springs,** another group of magnesic springs that are associated with serpentinous rock, rise at the border of a small meadow on a low saddle between two ravines 18 miles southeast of Livermore. The group, which is known as Sweet Springs, includes 10 that issue for a space of 200 yards along the southeastern side of the meadow and 4 others that issue on its eastern side. They range in size from mere seepages to flows of 6 or 8 gallons a minute, the total yield being perhaps 30 gallons a minute. The water has a distinctly sweet taste. The locality has been used by range stock as a watering place.

"The principal springs rise from the northern border of an area of pyroxene rock and serpentine which cover the slopes to the south, the slopes north of the springs being of siliceous sandstone. The sandstone probably belongs to the Franciscan group of altered sediments, which occupies considerable areas in the Coast Ranges, and the serpentine bears its usual intrusive relation to the sediments.

"**Warm Springs.** Four warm springs that issue on a hillside bordering the lowland at the southeast end of San Francisco Bay have given the small town of Warm Springs its name. They are situated about 2 miles northeast of the town, within the private grounds of Mr. Joseph W. Stanford. One of the springs rises in the lawn adjacent

[1] Anderson, Winslow, Mineral Springs and Health Resorts of California, p. 223, 1892.

to Mr. Stanford's residence. It has been inclosed to form a covered reservoir about 12 feet square, which furnishes part of the domestic supply and yields perhaps 5 gallons a minute. Two other springs rise beside a walk a few yards away, in open basins from which there are flows of approximately 1 and 4 gallons. The larger of these springs has a temperature of 86°. The fourth spring is 200 yards southward, in a little swale on the southern side of a knoll. It yields perhaps 5 gallons a minute, of water 90° in temperature, which is collected in a small covered reservoir and piped to the grounds for domestic and garden use.

"The water of all the springs is faintly sulphureted and is considered to be somewhat mineralized by sodium salts. Sandstone, gravel and some calcareous material form the hill slopes here."

PYRITES.

Massive irregular shaped deposits of pyrites occur in rhyolite at Leona Heights, about 4 miles southeast of the City Hall at Oakland. These deposits have been mined for many years, the pyrites being used exclusively for the manufacture of sulphuric acid. The ore contains occasionally small masses of chalcopyrite mixed with the pyrite, as well as small quantities of gold and silver.

In discussing the origin of these deposits Andrew C. Lawson* states: "The deposits are metasomatic replacements of the rhyolite, formed at a time when the ground water stood higher with reference to the ore bodies than it does at present. The retreat of the ground water to lower levels, owing to the deformation and dissection of the region, has led to the partial oxidation of some of these deposits and the consequent production of gossans of hematite and limonite. . . . It is worthy of note that these pyritic deposits are confined to the rhyolite and that the unoxidized rock contains minute crystals of pyrite, which are rather thickly but sporadically scattered through it, and also that the rhyolite is the only rock in the district containing disseminated pyrite crystals.

"It is probable not only that the ore replaced the rhyolite but that the materials that were originally disseminated through the rock have been concentrated during the process of replacement. The rhyolite has been decomposed by sulphuric acid produced by the oxidation of the disseminated pyrite near the surface of the rhyolite. The formation was originally much thicker than it is now, and as the surface was gradually lowered by erosion the process has been continuous. Theoretically, one result of the process, besides the chemical attack on the silicates, should be that, as the available oxygen became exhausted near the surface, the ferrous sulphate would descend to lower parts of the formation and be reduced in the ground water to sulphide. The course of these descending solutions and the sites favorable to the precipitation of the sulphides on reduction would be determined by the rock structure. The deposits are very similar in their essential features to larger and more cupriferous deposits in similar rocks elsewhere, many of which have been explained as the result of ascending magmatic water. The genesis of the deposits at

*U. S. G. S. San Francisco Folio, p. 22.

Leona Heights, however, is apparently simpler; they may be ascribed to the action of ordinary meteoric water."

Alma Mine. This property, opened in 1892, is operated by the Stauffer Chemical Company, 624 California street, San Francisco. The ore body strikes northwest and southeast, varying in width from 12 to 18 feet. It has been developed by over 5000 feet of tunnels and drifts. The old workings took fire and were abandoned, and a new adit was driven to cut the ore body at a lower level. Gravity trams are used for hauling ore to a small crushing plant and bunkers alongside of the railroad. The ore is used by the Stauffer Chemical Company, in their plant at Stege, Contra Costa County, for the manufacture of sulphuric acid.

Bibl.: Bulls. 38, p. 349; 50, p. 169.

Leona Heights Mine lies about 1 mile to the south of the Alma mine on the strike of its ore bearing zone. The deposit here is very irregular and considerably faulted, varying in width from 10 to 30 feet. Development consists of 2 tunnels, 100 feet vertically apart, the lower being about 400 feet long. A winze sunk 40 feet in the lower or main working tunnel showed good ore at bottom. The workings extend to about 20 feet above the upper level. There are about 1000 feet of tunnels and drifts in the mine. The ground is soft and wet and requires heavy timbering; square sets are used throughout. The mine is equipped with a crushing plant, consisting of a Blake jaw crusher, set of 16″ rolls, screens, etc., operated by a 30-h.p. gas engine. The ore is crushed by a $\frac{3}{8}$″ size before being trammed in the 1600′ aerial tramway, to the bunkers at the railroad. An average of 400 tons of ore, averaging at least 46% sulphur are produced per month. Six men are employed. This property is owned by the Realty Syndicate of Oakland, but is operated under lease by the Leona Chemical Company, of which D. A. McDonnell, Syndicate Building, Oakland, is president and general manager.

Bibl.: Bulls. 38, p. 349; 50, p. 170.

SALT.

The recovery of salt by evaporating the water of San Francisco Bay in the marshes along the east shore has been an important industry for many years. Refineries have been established at the larger properties for the production of table and dairy salt, while at the smaller ones only the crude salt is produced.

The waters are pumped into clay vats, which vary in area from 1 acre to 20 acres. As evaporation progresses, the water is drawn from one vat to another until it is sufficiently concentrated for the salt to crystallize. The salt is gathered during the fall of the year, before the winter rains commence.

Those at present engaged in this profitable industry in Alameda County are as follows:

American Salt Company. Mrs. Mary Marsicano, 781 Green street, San Francisco, owner; office, 611 Broadway, San Francisco. Property 2 miles west of Mount Eden. Solar evaporation. Only crude salt produced. Six men employed.

California Salt Company, 762 Mills Building, San Francisco. This company, established in 1901, owns and operates three salt works, two of which are located southwest of Alvarado, the third at Hayward Landing, the property embracing about 6000 acres of marsh land. Their refinery is located 3 miles southwest of Alvarado. The treatment here for the production of table and high grade salts is radically different from the processes employed at the other plants around the bay.

Evaporation in the solar vats is only carried on until the solution becomes saturated, being then transferred to a large tank into which soda ash is introduced to precipitate the magnesium salts present. The solution is pumped into a series of six 25,000-gallon tanks, where the magnesium salts are allowed to settle. The brine is drawn off into concrete vats and pumped into vacuum pans where the final precipitation is accomplished.

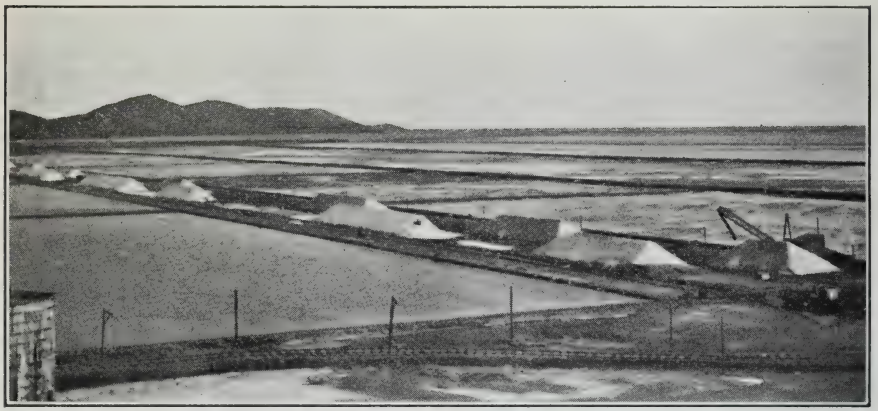

Photo No. 1. Solar evaporation vats and salt stacks at the California Salt Works southwest of Alvarado, California.

The salt for other purposes than table and dairy, is produced by evaporating to dryness in the clay vats, washing, drying in wooden driers, crushing and screening. The vacuum plant is equipped with 4 pans, each with a daily capacity of 25 tons; the crushing plant is equipped with two 6′ x 34′ rotary driers, 3 sets of rolls and revolving screens, having a total daily capacity of 100 tons. A 500-h.p. oil burning boiler generates steam for pans, as well as for motors which operate the plant. Ninety Japanese laborers are employed throughout the year. W. G. Henshaw is president, and H. C. Coward, manager.

Commercial Salt Company. The works are located 2 miles west of Baumberg Station. Only the crude rock salt is produced. From 2 to 10 men are employed during the harvest.

Continental Salt and Chemical Company, 1 Drumm street, San Francisco. The works are located 1½ miles west of Alvarado, adjoining the property of the California Salt Company. There is a large storage house which has a capacity of 30,000 tons, and the salt immediately after harvest is stored here to protect it from the elements until ready for the refinery. The process employed is one of thoroughly washing the salt crystals to free of impurities. This is accomplished by first

treating with two washes of cold brine, followed by a boiling hot brine wash, and lastly a hot fresh artesian water wash. A system of drain drags transfers the salt to the different washes, as well as through the original drier designed by the company. The capacity of the plant is 200 tons daily. Thirty men are employed. V. S. Hardy is president and L. Largente, secretary.

Crystal Salt Company. This company produces salt at two locations, one southwest of Alvarado, the other near Newark. Twenty men are employed during the harvest. Only crude salt is produced. Plummer Brothers Estate, 37 Front street, San Francisco, owner.

The Pioneer Salt Company. This company owns over 500 acres of marsh land, 3 miles southwest of Mount Eden, and have been in operation for many years. Solar evaporation is carried on in mud vats and the salt is harvested and stacked during the autumn. It is washed and ground, several thousand tons being produced annually.

A. L. Johnson, R. F. D. No. 2, Hayward, produces a small quantity of salt each year, the works being west of Mount Eden Three men are employed during the harvest.

A. Lindenberg, R. F. D. No. 2, Hayward. The works are 2 miles west of Russel Station, comprising 60 acres of marsh land. One man is employed.

Madson Salt Works. Situated $1\frac{1}{2}$ miles west of Russel Station. The work is performed by Japanese labor on contract. About 1000 tons of rock salt are harvested yearly. Formerly owned by C. Madson and Sons, R. F. D. No. 2, Hayward. Sold to California Salt Company in 1918.

Peter Mathiesen, R. F. D. No. 2, Hayward, produces a small quantity of salt each year, employing 2 men during the harvest.

The Oliver Salt Works, established in 1872, is 2 miles southwest of Mount Eden. The salt is evaporated to dryness in the clay vats,

Photo No. 2. Washing and stacking machine at The Oliver Salt Works. The salt is shoveled onto the side dump cars shown in foreground and hauled by gasoline motor to the plant.

which cover several hundred acres, and hauled in 1-ton cars by gasoline motors to the mill, where it is thoroughly washed, dried, and granulated. From 50 to 130 men are employed during the year, according to the season, producing about 30,000 tons yearly. The company has erected a chemical plant and is manufacturing magnesium chloride, magnesium sulphate, and potash salts as a by-product from the mother liquor. The magnesium sulphate ($MgSO_4$) runs 99.81% pure; the potassium chloride (KCl) from 76% to 95%, and a potash fertilizer is manufactured which runs from 10% to 30% K_2O. A. A. Oliver of Mount Eden is manager.

A. Schilling and Company of San Francisco own a large acreage of marsh lands between Alvarado and Newark and have a plant of considerable size for the production of salt.

Solar Salt Works, owned by the B. F. Barton Estate, are located 3 miles southeast of Mount Eden. The salt after being gathered is washed and granulated. A small gas engine is used to operate the plant. Several thousand tons are produced yearly. Six men are employed during the year. W. F. Barton, 10 East street, San Francisco, is in charge of the property.

Martin Tuckson owns 47 acres of marsh lands west of Russel Station and produces a small quantity of rock salt each year. It is not refined.

Union Pacific Salt Company operates a large plant 3 miles west of Mount Eden at the edge of the bay. This property is equipped with 100 wooden vats, each 225 feet long, 16 feet wide, and 10 to 12 inches deep, in which the saturated brine is introduced for the final evaporation. Each of these vats is thoroughly cleaned before the solution is introduced, thus insuring a clean product. The salt is shoveled into $1\frac{1}{4}$-ton cars and hauled to the mill, where it is washed, first using brine, then fresh water. After washing it is passed through rotary driers equipped with steam jackets, then ground and sized. Thirty Japanese laborers are employed at 18 cents per hour. W. F. Barton, 10 East street, San Francisco, is president and manager.

STONE INDUSTRY.

The **California Building Materials Company** operates a large plant on Alameda Creek at Niles. A combination drag line and slack line scraper electrically operated is used to excavate and convey the material to the mill, where it is crushed, screened and washed, then stored in bunkers below from which it can be loaded directly into cars. A Brown-Holt steam crane is used for switching purposes and for loading cars from the reserve dumps in the yard. Electric power from the Pacific Gas and Electric Company runs the mill. Water for washing the sand and gravel is pumped from wells on the property. F. N. Woods, Jr., is president and manager; the home office at 500 New Call Building, San Francisco. This company has recently obtained possession of the Grant gravel pit, described below.

Cañon Gravel Company, formerly known as the **Niles Cañon Stone Products Company**. Located in Niles Cañon, about ½ mile east of Niles. The plant was built in the latter part of 1916 and remodeled, January to March, 1918. The gravel is excavated from the bed of Alameda Creek by an electrically operated drag line scraper. The crushing plant consists of a grizzly, two gyratory crushers, a No. 5 and a No. 2, and a 16-foot revolving screen in 4 sections. The product is washed while being screened, water being furnished at the rate of 500 gallons per minute by a 35-h.p. motor and a vertical centrifugal Byron-Jackson 4″ pump. A 100-h.p. motor operates the scraper, a 50-h.p. motor runs the crusher and a 30-h.p. the screen. The capacity of the plant is 300 tons per 8 hours. It does not run continuously but as the demand for the product warrants.

Elliot Gravel Pit, owned and operated by the Southern Pacific Railroad, is about 2 miles east of Pleasanton at Elliot siding along the Arroyo del Valle. The gravel is excavated by a steam shovel which loads directly onto gondolas, the material being used without further treatment for ballast or concrete work.

Bibl.: Bull. 38, p. 313.

Estudillo Quarry. This quarry is located on the Foothill boulevard opposite Estudillo avenue. The stone is an altered basic rock, much fractured with serpentine in the seams. Very little quarrying has been done here recently, and the crusher has been removed. Mrs. Matilda Ravekes of San Leandro is owner.

Bibl.: Bull. 38, p. 313.

Grant Gravel Pit is located at Elliot siding 2 miles east of Pleasanton, and adjoins the pit of the Southern Pacific Railroad on the west. Until just recently, the early part of 1919, this was operated by the Grant Gravel Company, J. D. Grant, president, and H. G. Hotchkins, superintendent. It is now in the possession of the California Building Materials Company, G. W. Woods, Jr., president, office 500 New Call Building, San Francisco, and is held partly under lease from the Southern Pacific Company and partly under ownership. Max Cazin is superintendent at the plant.

The old company operated very little during the last year or so due to curtailed demand during the war. There is an enormous deposit of gravel here along the bed of the Arroyo del Valle.

There are two drag line scrapers, electrically operated, with a crusher in conjunction with each scraper. These dump the gravel into chutes and it is then loaded directly into large side dump cars, and hauled to the crushing plant by a small locomotive. After re-crushing, the material is conveyed to the screening or sizing plant, which is a separate unit, by belt conveyors. The capacity of plant when in full operation is about 2000 tons per day. The new company had not up to May, 1919, put the plant in operation. It expects to produce the following products: Regular concrete rock from ½″ to 1½″ size; small concrete rock from ¼″ up to 1″; so-called ''pea gravel''; sand, and what is termed ''straight run,'' which is gravel direct from the river bed, with or without crushing, but without screening or sizing. Pea gravel is used for roofing material, yard surfacing material, etc. Straight run is used mostly for ballast.

The **Lake Chabot Quarry** is 2 miles east of San Leandro south and across the cañon from the dam at the foot of Lake Chabot. It was opened in 1886 by the E. B. and A. L. Stone Company, who erected a crushing plant and operated the quarry for many years. It was later sold to D. V. Toffelmier of San Leandro. The rock is a hard blue metamorphosed sandstone with a heavy overburden of red jasper. In places the jasper is decomposed to a red dirt. Only the jasper is being quarried. It is used for road material in the vicinity.

Bibl.: Bull. 38, p. 315.

Leona Heights Quarry. This property, located on the summit of a prominent ridge about 4 miles east of Broadway, Oakland, has been worked for over 20 years. It was opened by the California Improvement Company, later becoming the property of the E. B. and A. L. Stone Company. In 1913 the new plant was constructed by the Leona Quarries Company, Incorporated, of which A. C. Brown was president and Frank W. Bilger, vice president and manager. It is understood the company went through insolvency and the quarry has not been worked for years.

The rock is a fine grained trap, well adapted for macadam and concrete. It was quarried in a glory hole approximately 500 feet long, 150 feet wide and from 90 to 130 feet deep. The rock was hauled about one-fourth mile in 4-yard cars by an electric motor through a tunnel, which connects with the bottom of the glory hole, to the head of a 1000-foot gravity tramway. At the foot of the tramway the crushing and sizing plant is located. This plant is equipped with one No. 8, two No. 5, and one No. 3 gyratory crushers; 36″ Simonds disc crusher; three 20-foot trammels; bucket elevator, and conveyors. It was operated by electric power, 400 h.p. being required. The capacity was 1000 yards per 10 hours. A spur track of the California Railroad runs to the bunkers below the crusher. At present time, May, 1919, it is understood that Bates and Boreland contemplate working this quarry.

Bibl.: Repts. XII, p. 388; XIII, p. 624. Bull. 38, p. 313.

Mountain View Cemetery Quarry. The Mountain View Cemetery Association formerly quarried a deposit of thin bedded red chert back of the cemetery which is located at the terminus of Piedmont avenue, Oakland. The rock was used for roadways about the cemetery. The quarry has been abandoned for some time.

Niles Sand, Gravel and Rock Company commenced operations in 1912, adjoining the plant of the California Building Materials Company on Alameda Creek. Here a large Lidgerwood drag line excavator operated by electric motors is used. This excavator runs on rollers and by means of a long boom gathers the material and deposits it in the cars that carry it up the inclined cable railway, where it is dumped into a hopper and fed on a belt conveyor that takes it to the top of the plant, where it is crushed, washed and sized. The motor installation on the excavator consists of a 112-h.p. motor to operate the drag line bucket, a 22-h.p. motor for working the excavator, and two 6-h.p. motors direct connected to air compressors to furnish air to operate the brakes.

The water for washing the material is pumped from fresh water wells adjacent to the plant by means of a 1000-gallon-per-minute centrifugal pump operated by a 50-h.p. motor. A locomotive crane is used for loading cars and switching purposes about the yard. The capacity of the plant is 1000 yards per 10 hours. Sixteen men are employed.

The home office is at 810 Mutual Bank Building, San Francisco; W. H. Ford is president and Howard C. Plummer, secretary and manager.

Oakland's Paving Company's Quarry. This is one of the largest quarries around the bay and has been worked almost continuously since 1870. It is situated on McAdams street, about two blocks east of Broadway, Oakland. The rock is a hard, fine grained, bluish gray metamorphosed sandstone, of the Franciscan formation. There are two large circular open cuts each, about 500 feet in diameter and from 100 to 130 feet deep. The rock is quarried in several benches, by air drills and by hand, and transferred to the crusher in 1-ton cars. The crushing plant is equipped with 5 gyratory crushers, two No. 5, two No. 4 and one No. 2, and has a capacity of 600 yards per day. There are 3 bucket elevators, trommels, etc. Electric power is furnished by the Great Western Power Company, about 270 h.p. being utilized. The products are $2\frac{1}{2}''$ macadam rock, $1\frac{1}{2}''$ and $1''$ concrete rock and $\frac{3}{4}''$, $\frac{1}{2}''$ and $\frac{1}{4}''$ screenings. The rock is sold for building construction and street work. Anson S. Blake is general manager and A. E. Bontrager is superintendent at the quarry. Home office, 5000 Broadway, Oakland.

Bibl.: Repts. X, p. 125; XII, p. 386; XIII, p. 624. Bull. 39, p. 312.

Ransome-Crummey Company formerly operated a quarry on the old Fish Ranch road, $5\frac{1}{2}$ miles southeast of the Oakland City Hall, on the same ridge and about 1 mile south of the Leona Heights Quarry. This is now owned by Bates and Boreland, Oakland Bank of Savings Building, Twelfth and Broadway, Oakland. The rock appears to be a continuation of the Leona Heights deposit, a hard, gray, trap rock. It is quarried in a large glory hole and the material hauled through a tunnel which is connected with the bottom of the hole to a 700-foot gravity tramway which feeds directly into the crushing plant alongside of the spur track at the foot of the ridge. The equipment at the plant consists of two No. 5 and one No. 3 gyratory crushers; 2 bucket elevators, and 3 trommels. Two 50-h.p. electric motors supply the necessary power to operate the plant, whose capacity is 600 yards per 10 hours. This plant has been idle for some time, but the present owners expect to operate it in the near future (May, 1919).

Bibl.: Bull. 38, p. 315.

George Small of Decoto has a deposit of moulding sand near Decoto, over a thousand tons of which were shipped to Oakland and San Francisco during 1916, for light plate moulding.

Spring Construction Company. The old quarry of this company, located on Greenwood Terrace, Berkeley, has been abandoned for years. The rock was used mostly for macadam roads in the vicinity of the quarry.

Bibl.: Bull. 38, p. 315.

Hyland Quarry of the Bates and Boreland Company, located in Dimond Cañon, about 2 miles east of Oakland. Operated at intervals as demand warrants.

MISCELLANEOUS CHEMICAL WORKS, COMMERCIAL PLANTS, ETC.

The **Air Reduction Sales Company** have a plant at Park avenue and Halleck street, Emeryville, for the production of oxygen from the air. This company has at present twenty-eight plants throughout the United States, twenty of which produce oxygen and eight of which produce acetylene. There are more plants under construction.

The air is drawn through two large cylindrical tanks about 20′ high and 4′ in diameter, in which the carbon dioxide (CO_2) is eliminated by caustic soda. The air goes to a compressor and then to an expansion engine, where it is liquefied. The liquid air is then treated in a "Claude" separating tank of French make, which separates the nitrogen from the oxygen. It has a capacity of 100 cubic meters per day. The oxygen is marketed in two sizes of steel cylinders, both under 1800 pounds pressure and containing 100 and 200 cubic feet respectively. About 85% of the product is sold to the shipyards, the balance going to garages, etc. About 30 men are employed. A. S. Blagden is president; home office, 120 Broadway, New York. K. L. Brackett is Pacific Coast manager, and G. B. Hunt is superintendent at the plant.

Barbour Chemical Company have a chemical works at 766 Fiftieth avenue, Fruitvale, for the manufacture of sulphuric and hydrochloric acid, barium sulphate, barium carbonate, barium nitrate and other products. It has not been in operation for the past year or so, during the latter part of 1918 and first part of 1919, owing to decline in market. When in operation the pyrite for the manufacture of acids was obtained from the Mountain Copper Company at Keswick, and the barytes from the deposit at El Portal, Mariposa County. There is a rotary kiln for burning the crude barytes.

Home office is in the American National Bank Building, 495 California street, San Francisco.

From latest reports (June, 1919) it is understood the property is about to be sold.

The **Judson Manufacturing Company** has for 35 years operated an iron and steel manufacturing plant at Emeryville station in West Oakland. Iron ores from Shasta County are utilized, also chrome, dolomite, limestone, silica, magnesite, manganese and fire clay from the state.

The plant consists of a structural steel shop, capacity about 1000 tons per month; modern machine shop; pattern, bolt and shafting shops; rolling mills; open hearth steel furnaces, etc.

Crude oil is used for fuel, about 7000 barrels being used per month. Plant machinery is run by electricity from the Pacific Gas and Electric Company, about 2000 h.p. being required. An average of 650 men are employed.

H. E. Bothia is president and D. L. Johnson general superintendent.

Paraffine Paint Company have a large plant at the foot of Powell street, Oakland, a few blocks north of Emeryville. It includes a roofing

manufacturing plant; paper mill; paint plant; linoleum plant; and an oil refinery for the manufacture of asphalt.

The products are paint, linoleum, wall board, and several kinds of roofing material. Some soapstone and lime rock from California are used, and the company owns an asbestos property near Placerville.

About 300 men are employed. R. S. Moore is president and the home office at 40 First street, San Francisco. This company also operates a paper and board mill at Antioch and one at Los Angeles.

Pacific Graphite Works, located at Fortieth and Linden streets, Oakland. W. C. Chedic owns the works, as well as a large deposit of graphite 3 miles south of Carson City, Nevada, the latter being held under the title of the Carson Black Lead Company. The lump graphite is shipped to the works, where it is ground in an 8′ x 4′ tube mill and refined and classified by air blowers. The silica falls first, and the different sized products are deposited in different chambers. It is sold for the manufacture of paints and lubricating oils.

The **Pacific Guano and Fertilizer Company** have a grinding and mixing plant at Second and Bristol streets, West Berkeley. The product is made by grinding and mixing together bones, shells, nitrate of soda, super-phosphate, sulphate of ammonia, blood, etc. The nitrate of soda is obtained from Chili, while the super-phosphate is made at the plant of the Union Super-phosphate Company, a subsidiary concern located at Stege, Contra Costa County. The principal market is throughout California and in the Hawaiian Islands. About 100 men are employed at the plant. Geo. N. Wilcox is president of the company; home office at 343 Sansome street, San Francisco; Mr. Anderson is superintendent.

Philadelphia Quartz Company of California. Works at Sixth and Grayson streets, West Berkeley. Principal product is silicate of soda, the production being about 1250 tons per month. It is marketed throughout the Pacific Coast and in Japan. The plant has been built about two years. From 25 to 30 men are employed. Clay and sand are obtained from Amador County, the two being separated at the plant. The sand is used for the production of the silicate of soda, and most of the clay is sold. The company has five plants in the East. G. R. Hunter is in charge of the works.

The **Pure Carbonic Company** have a plant at Third and Virginia streets, West Berkeley, for the manufacture of carbon dioxide (CO_2). The lime rock is obtained from Santa Cruz County. There are two vertical furnaces, only one of which is now in use, the other being old style. About 700 pounds of rock are put in for each charge, and 70 pounds of coke are required, per charge, for fuel. The time required for each charge is about three-quarters of an hour. The carbon dioxide is carried from near the top of the furnace, and after various treatments is marketed in two sizes of steel cylinders, holding 20 and 50 pounds respectively, and each under 1000 pounds pressure. The production is about 7000 cylinders per 16 hours. The larger cylinders can be filled practically as fast as the smaller ones. The carbon dioxide is used for extinguishing fires, charging mineral water, etc. About 2000 cylinders were recently (April, 1919) sent to the Argonaut mine, Amador County, to extinguish the fire in that mine.

The **San Francisco Sulphur Works,** located at Seventh street and Snyder avenue, West Berkeley, is owned by the Stauffer Chemical Company, home office 624 California street, San Francisco. This is a sulphur refinery, the raw material coming from Texas, Louisiana and Japan. The process consists of sublimination, condensation, grinding and classification through various sized screens. The products are various grades of pure sulphur.

An oil refinery at the same plant is near completion (May, 1919), at which it is planned to manufacture all kinds of vegetable oils, such as cocoanut oil, etc.

Standard Chemical Company. T. Seymour Hall, manager. Plant located at Emeryville; formerly in East Oakland. Products are tree and plant sprays, for insects, mildew, etc.; plant stimulant; rodent poison; and a cooling compound for steel cutting tools. Some sulphur is used, which is obtained from the San Francisco Sulphur Company (Stauffer Chemical Company).

West Coast Calsomine Company. Located at Fifty-first and Grayson streets, West Berkeley, on the main line of the Southern Pacific Railroad. The siding is called Livny. The products are calsomine, whiting, graphite, ochres, yellow iron oxides, etc. Chalk is obtained from England; limestone from El Dorado County, about 5000 tons per year; barytes from Nevada County, 2000 tons per year; clay from Lincoln, Placer County, 1000 tons per year; graphite from the state of Nevada, 200 tons per year. About 50 men are employed. John Stauffer is president, and C. W. Norrell, secretary.

COLUSA COUNTY.

Colusa County is one of the Sacramento Valley counties whose western edge extends into the Coast ranges. Its mineral resources are confined principally to that section. Gold was produced at the Manzanita Mine as early as 1865. Quicksilver production began in 1875. The total value of its mineral products to date has amounted to several million dollars. The principal products have been sandstone, mineral water, quicksilver, gold and silver, stone industry, salt, brick and chromite. These deposits and other undeveloped mineral resources are described in detail in the Fourteenth Report of the State Mineralogist. Bulletin No. 76 covers the manganese and chromite deposits and Bulletin No. 78 contains detailed description of the quicksilver mines of the county.

During the year 1920 active operations have been carried on in developing gold and quicksilver properties, mineral water and petroleum. Chrome and manganese mining ceased on the signing of the armistice. Changes in ownership have been noted.

Table of Mineral Production.

Year	Gold and silver	Quicksilver		Sandstone		Mineral water		Stone industry	Miscellaneous and unapportioned
	Value	Flasks	Value	Cu. ft.	Value	Gallons	Value	Value	
1875		700	$58,905						
1876		407	17,908						
1877		466	17,382						
1878									
1879									
1880	*$4,908								
1881	3,500								
1882	2,575								
1883	1,000								
1884	1,530								
1885	45,000								
1886	11,617								
1887	7,461								
1888	6,000								
1889	13,626								
1890	2,810								
1891									
1892									
1893	300								
1894				20,000	$7,500				
1895		1	40						40 tons, $400; salt
1896		58	2,054			50,090	$12,530		
1897		43	1,510			31,500	1,620		8 tons, 160; salt
1898						21,000	1,050		21 tons, 439; salt
1899						5,000	1,120		20 tons, 300; salt
1900		275	12,359			53,500	12,350		20 tons, 80; salt
1901	1,800	235	10,575	88,981	80,082	92,200	20,220		18 tons, 270; salt
1902	850	605	26,100	99,395	87,456	142,305	79,698		270 M., 2160; brick
1903		510	21,708	146,828	312,500	174,000	85,900		18 tons, 396; salt
1904		†400	16,526	100,000	290,000	156,170	38,051	$1,250	18 tons, 360; salt
1905		326	12,321	118,954	276,908	160,000	80,000		18 tons, 180; salt
1906				88,821	101,802	197,375	49,344		300 M., 1800; brick
1907	742	17	648	86,954	78,259	254,075	51,233	3,500	18 tons, 225: salt
1908	584	21	900	73,284	43,971	200,000	88,000	850	150 tons, 1700; salt
1909		11	545	47,070	24,034	150,000	75,000	620	16 tons, 240; salt

1910				112,947	56,505	150,000	75,000	16,500	10 tons, 125; salt
1911		5	230	101,029	50,027	136,300	68,150	16,702	1596; unapp.
1912				51,137	15,804	165,330	39,061	15,300	
1913				34,927	15,550	132,720	32,931		
1914				16,000	7,300	92,000	24,951		
1915						91,480	15,003	1,000	
1916		285	26,648					550	(1) $15,605
1917								600	(2) 15,721
1918								700	(3) 15,700
1919								4,900	(4) 2,400
Totals	$104,303	4,365	$226,359	1,186,327	$1,448,298	2,455,045	$851,212	$62,472	$59,857

Totals.

Gold and silver	$104,303
Quicksilver	226,359
Sandstone	1,448,298
Mineral Water	851,212
Stone industry	62,472
Miscellaneous and unapportioned	59,857
Grand total	$2,752,501

*1880 to 1890, U. S. Mint Reports.
†Flasks of 75 pounds since 1904; previously 76½ pounds.

Cerise Mine. This property was formerly a part of the Manzanita mine and also includes the old Cherry gold mine. It is situated in the Sulphur Creek district, section 29, T. 14 N., R. 5 W. Owners, Ellis, Turman and Austin; Geo. C. Ellis, president; Frank Turman, secretary; Chas. L. Austin, general manager; post office, Wilbur Springs. The nearest railroad connection is at Williams, twenty-six miles east, reached by good automobile road direct from mine. There is no timber. Water from Bear Creek is piped 8000 feet to the property, which lies at an elevation of 1400. The mine was discovered in 1863 by Cherry, Northey et al., and was worked intermittently until 1916, when it was taken over by Chas. L. Austin. The Manzanita claim was located February 21, 1863, the Monticello, March 19, 1863, the North Star, March 12, 1883, the Monticello mill site and Hughs mill site, March 19, 1883. All were patented in 1893. The total area is about one hundred acres and the claims cover the lode for 2000 feet.

The country rock is slate and serpentine. The deposit consists of mineralized slate beds without definite walls. Values are confined to seams in the oxide zone. Below twenty feet sulphides appear disturbed throughout the whole rock. The gold is finely divided and combined with various mineral salts.

The mineralized beds average about one hundred feet wide and have a general northerly strike and easterly dip. These beds have a proven length on the surface of three hundred feet each. The greatest vertical depth below the outcrop is one hundred feet, reached by tunnel. Tunnels and drifts totaling 1000 feet have been run, 300 feet being in ore. Ore reserves are estimated by the management to approximate 500,000 tons. The method of mining will be by quarrying. The mine is equipped with three semi-Deisel engines, three gas engines, ball mill, machine shop and assay office.

The ore carries both cinnabar and gold and during the past four years efforts have been directed to developing a process for the recovery of the gold. Reduction equipment has not been decided upon, as experimental work is still being carried on.

Prospecting was active at the time of visit, with six men employed. Sinking costs $25 per foot. Labor is paid $5 a day; transportation one-half cent a pound. Details in regard to former operations are described in Bulletin No. 78 under "Manzanita Mine."

Clyde Mine. San Francisco capitalists took over this property under lease and bond in 1919 and active development work was carried on for some months, but it was stated that the ore bodies did not prove of sufficient size to warrant further work and operations ceased. The mine has been idle since.

MANGANESE.

Manzanita Mine. (See under Quicksilver.)

Black Diamond Manganese Mine. Abandoned.

MINERAL PAINT.

Ruby King Mineral Paint Company. The mill at this property has been closed down and dismantled, but some shipments of crude ore have been made.

MINERAL WATER.

Cooks Mineral Spring. This spring was not opened as a resort during the year, but casual parties can find camping accommodations. A small amount of water was bottled for shipment.

Jones Hot Sulphur Springs. These springs have been purchased by the Wilbur Springs Company and are now a part of the Wilbur Springs property.

Wilbur Hot Sulphur Springs. J. W. Cuthbert, owner, F. K. Lippitt having retired. A new concrete hotel was erected in 1915.

PETROLEUM.

Active prospecting for oil began at several points in Colusa County during the year. The **Mountain House Standard Oil Company** began drilling near Mountain House (Venado post office) and had reached a depth of seventy feet at the time of visit. The **Blue Ridge Petroleum Company** were erecting a rig west of Arbuckle preparatory to drilling. A report on these and other operations will be found in Bulletin No. 89, now in preparation.

QUICKSILVER.

None of the quicksilver properties of Colusa County were in operation during the year, with the exception of the Cerise mine, the ore of which carries gold values. See under Gold and Silver.

Empire Group. Now owned by R. A. Boggess, 1610 Sutter street, San Francisco.

Manzanita Mine. This property has been purchased by the Wilbur Springs Company. Idle.

Wide Awake Mine. Owner A. A. Gibson, Oakland.

SANDSTONE.

Both the **Colusa Sandstone Company's** quarry and the **McGilvray Stone Company's** quarries near Sites have been closed down and the narrow gauge railroad which formerly connected with the Southern Pacific main line at Colusa Junction has been torn up.

CONTRA COSTA COUNTY.

By E. Huguenin and W. O. Castello.

(Field Work in 1919.)

INTRODUCTION.

Contra Costa County, created February 18, 1850, is one of the East Bay counties and adjoins Alameda County on the north. It has a water front of 70 miles, nearly all of which is on deep water, and a land area of 714 square miles, approximately 400 square miles of which are under cultivation. Its population as estimated from registration figures for 1918 is around 65,000.

The county is traversed by both the Southern Pacific and the Santa Fe Railroad, the former following the coast line throughout its length. Its proximity to San Francisco, together with its deep water frontage and excellent railroad facilities, has led to the establishment of many important industries along its shore. Among the most important of these may be mentioned the Standard Oil Refinery at Richmond; the Union Oil Refinery at Oleum; the Selby Smelter at Selby; the California and Hawaiian Sugar Refinery at Crockett; the Mountain Copper Company's Smelter, and the Shell and Associated Oil Refineries near Martinez; and the Pacific Coast Shipbuilding Company's shipyards at Bay Point.

Richmond is the largest city, having a population of about 25,000. It is the terminus of the Santa Fe Railroad and essentially an industrial city. Here are located the Standard Oil Refinery, the Pullman Car Shops, Western Pipe and Steel Company, Pacific Porcelain Ware Company, Los Angeles Pressed Brick Company, Santa Fe Shops, and many other important industries.

Martinez, with a population of 5000 is the county seat. It is located on Carquinez Straits which forms the boundary line between Contra Costa and Solano counties. Antioch, Pittsburg, Bay Point, Port Costa, and Crockett, all located along the northern waterfront, are important industrial towns.

Two ridges of the Coast Range Mountains strike northwest and southeast across the county, the most prominent being the eastern ridge which culminates in Mount Diablo at an elevation of 3849 feet above sea level. This peak is an important landmark, being visible from all the surrounding country, and forming the western boundary of the San Joaquin Valley at this place. The western ridge lies close to the coast and its crest is more regular, but its highest peaks are less than 2000 ft. in elevation above the sea level. Extending westward from this range is a wide plateau which slopes gently towards San Francisco Bay. San Ramon Creek flowing northward across the middle of the county between the two ridges, joins Walnut Creek which empties into Suisun Bay, Marsh Creek, which rises in the east slopes of Diablo, flows northeastward into the San Joaquin River. These are the only streams of importance in the county.

MINERAL RESOURCES.

Comparatively few minerals are produced in Contra Costa County, with the exception of the structural materials, brick, cement, limestone, and crushed rock. The coal fields on the northwesterly slope of Mount Diablo, opened in 1865, were large producers up until 1903, since which time very little coal has been mined. The mines are now practically idle. The production of mineral water from Alhambra Springs near Martinez has been an established industry for the past twenty years.

The minerals in order of their value are: cement; crushed rock and sand, combined under the heading stone industry; brick; coal; limestone; lime, mineral water, and under the miscellaneous item, asbestos, clay and copper.

Other minerals that are known to occur in the county are manganese, quicksilver, and soapstone.

BRICK AND CLAY.

The **Carquinez Brick and Tile Company** formerly operated a brick yard at Eckley, near Port Costa, for the manufacture of common red brick. The property has been idle since 1914, and the plant was torn down in 1918. R. W. Harrison, 149 California street, San Francisco, is president.

N. Clark and Sons. This company formerly quarried a deposit of calcareous shale at Walnut Creek, ½ mile north of the town on the Southern Pacific Railroad. It has not been worked for some time, as part of the Alameda pottery was destroyed by fire in July, 1917. It is now being rebuilt and no doubt the quarry will be worked again in the near future. The shales are thin bedded and the deposit is developed by an open cut whose face is approximately 150′ wide and 70′ high. The material is broken down by hand drilling and blasting, through a chute onto a loading platform alongside of the railroad. It is shipped to their plant at Alameda, where it is used as a filler in the pottery work. (See under Alameda County.)

The **Coast Firebrick Company** in the early part of 1919 completed the construction of an extensive plant at Richmond. The home office is in the Oakland Bank of Savings Building, Oakland, Mr. Lynn in charge. The company will manufacture fire brick and other clay products.

Diamond Brick Company, 242 Balboa Building, San Francisco; Sumner Crosby, secretary. A brick yard for the manufacture of common red brick was built at Pittsburg by this company in 1915. The plant was abandoned, and has been partially dismantled.

Los Angeles Pressed Brick Company. (See Richmond Pressed Brick Works.)

Pacific Porcelain Ware Company. Home office, 67 New Montgomery street, San Francisco; Newton W. Stern, president and general manager. The works of this company are at Richmond, and are very extensive, consisting of two vitreous china plants, one of which is at San Pablo, for the manufacture of all types of sanitary porcelain ware,

and a porcelain enamel cast iron ware plant. The minerals used in the manufacture of the porcelain ware are shipped to the plants from the several different counties as follows: fire clay from Amador, common clay, Napa; quartz, Placer, and feldspar from Monterey, San Bernardino and Tulare counties. Borax is supplied by the Pacific Coast Borax Company. The quartz and feldspars are used for the glazing.

For the manufacture of porcelain ware the clay is first thoroughly mixed in solution, then screened and filtered through a press to get rid of water. Cakes from press containing 25% moisture are put through the pug mill and the clay is then ready for moulding. All moulding is hand work. The moulded objects are allowed to dry and

Photo No. 3. Moulding room at the Richmond plant of the Pacific Porcelain Ware Company.

then burned in updraught kilns, after which the glaze is applied, by submerging the object in the glaze solutions. It is then dried and reburned to produce the final glaze. The drying is done in steam heated rooms. The plants are equipped with 9 updraught kilns using crude oil fuel.

The feldspar and quartz are crushed at the San Pablo plant. This is equipped with a Joshua Hendy jaw crusher and a 6′ Hardinge mill, as well as 2 ball mills. The Hardinge mill has lately been installed to replace the ball mills. Electric power is used to operate the plant. Over 100 men are employed by the company. W. C. Potter is superintendent.

Port Costa Brick Company owns and operates a brick yard ¾ mile east of Port Costa at edge of Carquinez Straits. A bank of blue shales, in places decomposed to reddish clay are quarried by pick and shovel

in a large open cut about 1000′ beyond the yard. It is shovelled into a large side dump car which is trammed by a gasoline motor to the works. The equipment consists of a stiff-mud machine and Hoffman continuous kiln. The capacity of the plant is 40,000 bricks daily. Electric power from the Great Western Power Company is used to run the works. About 300 h.p. is utilized. Twenty-five men are employed during the season. Only common red bricks are manufactured. C. G. Berg is president and W. S. Hoyt, secretary; home office 119 Jessie street, San Francisco; B. F. Ferrario, superintendent at the plant.

Richmond Brick Company formerly operated a brick yard 1 mile west of Richmond. The plant, equipped with a patent kiln of the company's design, has been idle for several years, and the company is disorganized.

Bibl.: Bull. 38, p. 242.

Richmond Pressed Brick Works. The Los Angeles Pressed Brick Company erected this plant at Point Richmond in 1907 for the manufacture of common red, vitrified, and fire brick, roofing and floor tile. The clay from which the common brick and tile are manufactured occurs in a hard bed varying up to 39′ in thickness, located on the hill back of the plant. A bank of red shale about 1000′ north of the yard is quarried for the manufacture of the paving brick. The clay is excavated by a drag line scraper, and must first be loosened by blasting. A gravity tram transports the material to the plant, which is equipped with a stiff mud machine, capacity 100,000; a Fernhold brick press, capacity 16,000; and three 36′ down-draught kilns. The common bricks are burned in field kilns. Electric power is used to operate the plant, and crude oil fuel in the kilns. From 15 to 20 men are employed during nine months of the year. The company operates several large brickyards in Los Angeles and Riverside counties. Howard Frost is president and H. B. Potter, secretary; home office, 410 Frost Building, Los Angeles.

CEMENT.

The **Cowell Portland Cement Plant** is situated about 10 miles southeast of Bay Point at the base of Lime Ridge. The Bay Point and Clayton Railroad, a standard-gauge road, connects the plant at Cowell with the main lines of both the Santa Fe and Southern Pacific railroads at Bay Point.

The quarry from which both the lime rock and clay are obtained is on the ridge back of the plant. The lime rock is a travertine which occurs as superficial deposits over the ridge; several of the patch-like deposits have been exhausted. It varies considerably in character, the greater part being compact and drab colored. In places it is bluish in color and brecciated. Small patches of porous white tufa are occasionally encountered mixed with the other rock.

The present working quarry is at the summit of the ridge. It is opened by a large semicircular cut whose face is about 20′ high and several hundred feet across. Air drills are used in quarrying, and after blasting the rock is loaded into 6-yard cars by steam shovels. A string of 3 cars is hauled by a dinkey engine ½ mile around the ridge, where

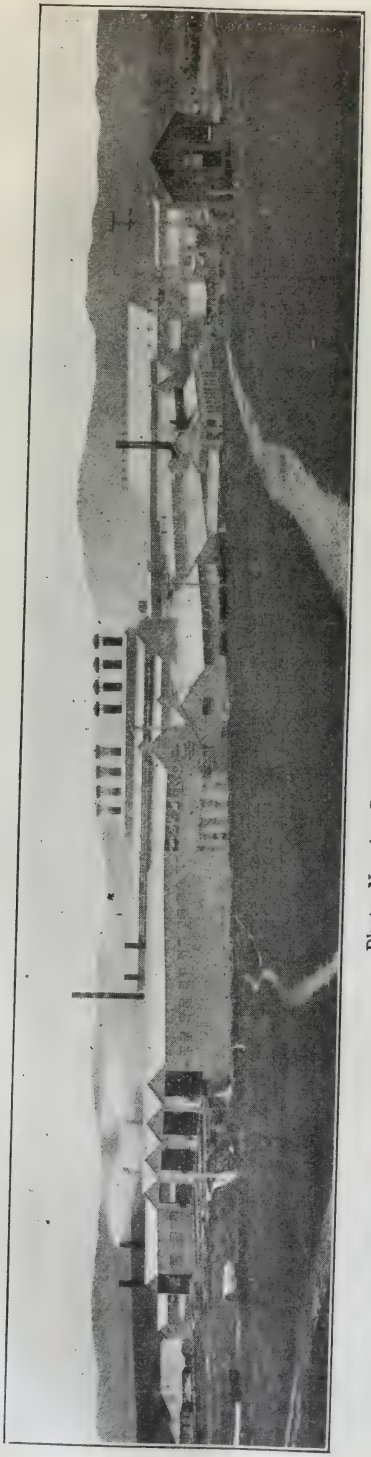

Photo No. 4. Cowell Portland Cement Plant.

the cars are transferred to a gravity tramway 1500 feet long. This transports the rock to the crusher at the terminus of the railroad, less than ½ mile from the cement mills. The rock is crushed and then hauled by a standard locomotive to the various bins at the plant.

From the bins the materials are fed to five 5′ x 60′ rotary driers, 2 of which are for the clay and the remaining three for the lime rock. The latter is then conveyed by a system of Peck carriers to 8 ball mills and subsequently to storage bins, where hourly samples are taken. The clay after drying is pulverized in 2 Williams pulverizers, and then stored in bins, from which also, hourly samples are taken. The proper mixture is then automatically made before being fed to the tube mills. Ten 5′ x 22′ and two 7′ x 22′ tube mills reduce the mixture to a fine powder, which is introduced to the kilns. There are 8 kilns 7½′ x 110′ in size. The temperature in the kilns is controlled by an original electric stack signal, designed and patented by the company, whereby a red light is flashed in a glass case bearing the kiln number, when the gas temperature in the stack exceeds a certain degree. The clinker is passed through four 5′ x 60′ rotary coolers, and then conveyed to the storage bins, which are housed in the same building with the kilns. The 40 bins have a total capacity of 125,000 bbls. The clinker is sampled, the samples being briquetted for strength tests, before it is pulverized. The ball mills and 14 tube mills perform this final operation.

Each ball mill, tube mill, and kiln is driven by an independent motor, so that any unit can be cut out without interferring with the operation of the remaining plant. The electric power to operate the entire plant is supplied by the Great Western Power Company, whose main transmission line crosses the property. It is delivered at 100,000 volts and reduced and distributed at 440 volts. It has been estimated that it requires 1 h.p. for each barrel of cement produced. The capacity of the plant is 4000 bbls. From 200 to 235 men are employed. Owner, Henry Cowell Lime and Cement Company, 2 Market street, San Francisco; W. H. George is general manager, and W. R. Kleckner, superintendent.

COAL.

The coal beds of Contra Costa County lie on the northern slopes of Mount Diablo, about 6 miles south of Pittsburg, and are limited to a belt about 2½ miles in extent, striking in a general east and west direction. The field became an actual producer in 1861, and was mined for many years. Several large mines were opened and railroads were constructed from both Pittsburg, formerly called Black Diamond, and Antioch to the field. The two largest producers were the Black Diamond and Pittsburg companies. The former is said to have produced over $1,000,000 during the period from 1865 to 1884. The coal beds were mined to water level, when work ceased, and they have been practically idle since 1902. The old buildings are gone and very little remains to attest to its former activity.

The beds are described by George Otis Smith of the U. S. G. S.* as follows: "The coal beds of the Mount Diablo field are three in number. The uppermost is the Clark, the next the Little, and the lowest the Black Diamond. The section of that part of the Eocene rocks in

*22d Annual Report, Part III, p. 500.

which the coal beds occur is quite variable, so that the stratigraphic distance between the Clark and the Black Diamond seams varies from 300 to 400 feet in different parts of the field. The Clark seam has been a favorite in the different mines, and has been worked continuously throughout the field. It has a thickness of from 2 to 4 feet of coal, which is generally free from slate, and the seam for the most part possesses a good floor and roof. As is the case with all the coal seams of California, the outcrop is generally a light, soft shale, not at all resembling coal, and marketable coal is not found in the seam until a depth of at least 100 feet is reached. The Little seam is more irregular in thickness, but where worked has about 2 feet of good, clean coal.

Photo No. 5. Old camp of Nortonville, looking northward; dumps of the Black Diamond Coal Mine in the foreground.

The character of the roof and footwall, however, makes this coal more expensive to mine than that in the Clark seam. This is also true of the Black Diamond seam, which, while the thickest seam of the three, having from 3 to 4 feet of coal, has associated with it such amounts of slate and bone as to make the mining expensive and often dangerous on account of the swelling of the bone, which causes crushing of mine timbers."

An analysis of the Black Diamond coal, as given by R. B. Smyington, former engineer for the Black Diamond coal mine, is as follows:

Water	10.5%
Volatile hydrocarbons	28.1%
Fixed carbon	40.7%
Ash	20.7%
	100.0%

The coal from this field can not compete with the harder coals from outside of the state for the ordinary commercial purposes, but its proximity to the growing industrial towns along the northern water front will undoubtedly cause it to be mined again. It can be used for producer gas or as fuel at the property to develop power which could be transmitted to the nearby towns.

Bibl.: Repts. VII, p. 142; VIII, p. 160; XII, pp. 43-46; XIII, pp. 51-52. U. S. G. S. 22d Annual Rept., Part III, p. 500.

LIME AND LIMESTONE.

Henry Cowell Lime and Cement Company's Quarry. The quarry has been described under the heading "Cement." It was first opened for the burning of lime and it was not until 1907 that the cement mills were erected. There are 4 standard continuous kilns below the quarry, but practically all of the limestone now produced is used in the manufacture of cement.

Bibl.: Bull. 38, pp. 66-67.

The **Spreckels Sugar Company** formerly operated a quarry on the same ridge, but about 2 miles south of the Cowell Company's quarry. The lime rock is travertine, essentially the same as that occurring on the Cowell property. It was shipped to the sugar mills at Crockett, and also to the Selby smelter, where it was used for fluxing purposes. The quarry was closed down in 1915 and later sold to the Henry Cowell Lime and Cement Company. All buildings have been removed and the property is used as a cattle range.

MANGANESE.

Manganese occurs on Red Rock in San Francisco Bay just off the Contra Costa coast, and included within the county limits. This deposit is described by A. C. Lawson* as follows: "The ore occurs on the southwest side of the island as an integral part of the radiolarian chert. The chert here has a west-northwest strike and a nearly vertical dip, and consists of the usual rhythmical alternation of thin beds of hard, flinty to quartzose chert, and partings of shale, the whole having a reddish color. . . . A belt parallel to the strike of the chert includes interstratified layers of psilomelane, which, by reason of their black color, present a bold contrast to the adjoining rocks. Most of the layers are about one-fourth to one-half inch thick and replace locally the usual shale parting, but in places the psilomelane is much thicker. Some of the layers of the chert adjoining these layers of psilomelane are also so charged with that mineral as to be quite black, though they are still hard and siliceous. The psilomelane also occurs in minute particles in the shale between the chert beds, making it black. The borders of the belt in which these layers of psilomelane occur are not sharply defined, but the mineral has been mined in open cuts from 2 to 6 feet wide. The ore appears to be essentially a primary deposit, contemporaneous with the deposition of the silica that formed the cherts, although doubtless some of the psilomelane has since migrated into adjoining beds."

*U. S. G. S. San Francisco Folio, No. 193, p. 23.

"The shale partings north of the manganese ore outcrop on Red Rock are abnormally thick, generally measuring from half an inch to 2 inches, and at some places the shale is 1 to 2 feet thick. It has a soft, earthy consistence, and a shaly structure and is prevailingly red, though the color grades locally into yellow. This shale was at one time mined as a mineral paint.

Some small bunches of manganese ore have been found on the southeast side of Mount Diablo, but nothing of commercial importance has as yet been developed.

MINERAL WATER.

Alhambra Springs. A group of 6 more or less mineralized springs are situated in a narrow cañon 6 miles south of Martinez in section 2, T. 1 N., R. 3 W. Three of the springs have been developed, but of these only two are utilized. The principal spring, known as No. 1, fills a housed-in pool 6 feet square on the eastern bank of the ravine. It is strongly saline, as shown in the analysis below. No. 2 spring rises in a cement-covered joint on the western edge of the stream channel several hundred yards south of No. 1. The waters of No. 2 are less strongly mineralized.

Analysis of Water from Alhambra Springs.

(Analyst, Thomas Price and Son; authority, advertising matter.)

	Grains per United States gallon	
	No. 1 Spring	No. 2 Spring
Calcium chloride	157.24	----------
Magnesium chloride	24.25	----------
Potassium chloride	7.58	1.395
Sodium chloride	492.65	2.028
Calcium bicarbonate	----------	19.247
Magnesium bicarbonate	----------	14.680
Sodium sulphate	2.48	15.548
Sodium sulphide	8.39	----------
Ferrous carbonate	1.16	----------
Aluminum oxide	----------	0.238
Aluminum sulphate	2.13	----------
Silicon dioxide	1.22	0.758
Total residue	697.10	53.894

Water from the two springs is piped to tanks and thence to the bottling works beside the railroad at Martinez. The waters of No. 2 are used in the manufacture of ginger ale and other carbonated drinks, while that of No. 1 is bottled for medical use. Various blends of the two waters are made for medicinal purposes. The waters have been on the market for over twenty years. Owner, Alhambra Mineral Springs Company, L. M. Lassell, Martinez, California.

Bibl.: Rept. XIII, p. 508; U. S. G. S. Water Supply Paper 338, pp. 293-294.

Byron Hot Springs.* "On the western border of San Joaquin Valley, near the eastern corner of Contra Costa County, a number of mineralized springs—Byron Hot Springs—rise in a saline flat that is

*U. S. G. S. Water Supply Paper 338, pp. 109–112.

partially inclosed by low hills. A large, well appointed hotel and four or five cottages have here formed one of the most noted spring resorts of the State. The place is easily reached by automobile from the eastern side of San Francisco Bay'' . . . ''A small, warm sulphur spring supplies a drinking basin in the main grounds; warm sulphur mud and water baths and a sulphur plunge are about 250 yards southeast of the hotel grounds. A strongly sulphureted spring, 83° in temperature, forms a slightly used drinking pool at one side of Sulphur Plunge, and on the opposite side is a well from which mineral water is pumped to bathtubs in the hotel.'' . . . ''About 250 yards beyond the Sulphur Baths and Sulphur Plunge is an inclosed swimming pool, known as the Gas Plunge, in which the temperature is about 88°. Between the two bathing establishments are two cemented drinking springs, known as the Hot Salt and the Liver and Kidney springs. The Hot Salt, with a temperature of 120° and a flow of about 2 gallons a minute, rises in a small, domed, concrete house; the Liver and Kidney Spring rises in a concrete basin 25 yards southward. In 1908 its temperature was 73°, but its flow was not appreciable. Near the base of a hill 250 yards to the southwest is a tile-lined basin or well, marked ''Surprise,'' which contains strongly saline water about 70° in temperature.

The following are analyses of waters from five of the springs:

Analyses of Water from Byron Hot Springs, Contra Costa County, California.

(Constituents are in parts per million.)

	1		2		3		4		5		6		7		8		9		10		11	
Temperature	24° C. (75° F.)		24° C. (75° F.)		21° C. (70° F.)		19°C.(67°F.)		19°C.(67°F.)		14°C.(58°F.)		50°C.(122°F.)		50°C.(122°F.)		49°C.(120°F.)		32°C.(90°F.)		23°C.(74°F.)	
Properties of reaction:																						
Primary salinity	51		46		50		84		85		83		82		82		79		93		82	
Secondary salinity	0		0		0		13		12		15		15		15		19		3		17	
Tertiary salinity	0		0		0		0		0		0		0		0		0		0		0	
Primary alkalinity	31		36		39		0		0		0		0		0		0		0		0	
Secondary alkalinity	18		18		11		3		3		2		3		3		2		4		1	
Tertiary alkalinity	178		141		23		Trace.		2		1		1		1		1		10		Trace.	
Constituents	By weight.	Reacting values.	By weight.	Reacting values.	By weight.	Reacting values.	By weight.	Reacting values.	By weight.	Reacting values.	By weight.	Reacting values.	By weight.	Reacting values.	By weight.	Reacting values.	By weight.	Reacting values.	By weight.	Reacting values.	By weight.	Reacting values.
Sodium (Na)	143	6.20	149	6.49	269	11.67	4,250	184.80	4,193	182.30	4,353	189.24	3,735	162.40	3,741	162.67	3,886	168.96	2,631	115.70	103,840	4,515.00
Potassium (K)	17	.42	23	.59	4.9	.12	296	7.56	307	7.84	43	1.09	318	8.12	324	8.28	33	.84	324	8.29	1,277	32.63
Lithium (Li)					0	.00	Tr.	Tr.			2.0	.29	Tr.	Tr.			12	1.71				
Ammonium (NH_4)					.1	.01	17	.93	18	.98	13	.71			.5	.03	10	.57	Tr.	Tr.	Tr.	Tr.
Barium (Ba)	Tr.	Tr.			Tr.	Tr.	13	.18	11	.16	7.8	.11	Tr.	Tr.	2.0	.03	6.2	.09	Tr.	Tr.	1.4	.02
Strontium (Sr)					Tr.	Tr.	Tr.	Tr.			.9	.02	Tr.	Tr.			.8	.02				
Calcium (Ca)	10	.50	10	.52	15	.77	554	27.67	538	26.81	583	29.09	604	30.16	605	30.19	701	34.96	113	5.61	14,980	747.44
Magnesium (Mg)	12	.98	12	1.01	8.8	.72	91	7.51	94	7.71	130	10.65	70	5.76	69	5.66	109	8.98	51	4.22	3,473	285.75
Iron (Fe)	2.1	.07	*2.2	.08	1.5	.05	5.6	.20	5.9	.21	3.2	.12	7.0	.25	7.0	.25	2.5	.09	5.9	.21	22	.80
Aluminum (Al)																						
Manganese (Mn)					0	.00					0	.00					0	.00				
Sulphate (SO_4)	38	.80	22	.45	60	1.25	15	.31	13	.28	Tr.	Tr.	11	.23	10	.21	Tr.	Tr.	38	.80	797	16.59
Nitrate (NO_3) and nitrite (NO_2)					0	.00					0	.00					0	.00				

Chloride (Cl)	117	3.29	125	3.52	190	5.34	7,861	221.68	7,755	218.70	7,982	225.09	7,125	200.92	7,142	201.40	7,527	212.27	4,504	127.02	195,050	5,500.66
Bromide (Br)	-----	-----	-----	-----	1.9	0.2	Tr.	Tr.	Tr.	Tr.	18	.23	Tr.	Tr.	Tr.	Tr.	18	.22	1.8	.02	.7	.01
Iodide (I)	-----	-----	-----	-----	2.1	.02	9.3	.07	10	.08	17	.13	Tr.	Tr.	0.4	Tr.	16	.13	9.8	.08	1.4	.01
Sulphide (S)	-----	-----	-----	-----	6.2	.39	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Carbonate (CO_3)	122	4.08	142	4.72	179	5.98	204	6.79	209	6.95	127	4.24	166	5.54	165	5.50	72	2.40	183	6.11	1,932	64.40
Metaborate (BO_2)	Tr.	Tr.	-----	-----	15	.35	Tr.	Tr.	-----	-----	69	1.60	Tr.	Tr.	-----	-----	48	1.11	-----	-----	-----	-----
Arsenate (AsO_4)	-----	-----	-----	-----	0	.00	-----	-----	-----	-----	0	.00	-----	-----	-----	-----	0	.00	-----	-----	-----	-----
Phosphate (PO_4)	-----	-----	-----	-----	1.0	.03	-----	-----	-----	-----	Tr.	Tr.	-----	-----	-----	-----	Tr.	Tr.	-----	-----	-----	-----
Silica (SiO_2)	54	1.78	*51	1.70	46	1.54	17	.57	17	.57	31	1.02	34	1.12	34	1.13	30	.99	19	.62	15	.40
	515.1	-----	536.2	-----	800.5	-----	13,332.9	-----	13,170.9	-----	13,379.9	-----	12,070.9	-----	12,099.9	-----	12,471.5	-----	7,910.5	-----	321,389.5	-----
Carbon dioxide (CO_2)	223	10.15	180	8.18	0	.00	-----	-----	66	3.02	14	.65	25	1.15	26	1.16	8.7	.40	218	9.90	Tr.	Tr.
Hydrogen sulphide (H_2S)	42	2.47	38	2.25	25	1.49	-----	-----	-----	-----	0.4	.02	-----	-----	-----	-----	.6	.04	53	3.10	-----	-----

*The silica and ferrous carbonate in the Anderson analysis were interchanged before recomputation, comparison with the other analyses indicating that a typographical error had resulted in a misstatement of these values.

1. White Sulphur Spring. Analyst, G E Colby (1887). Authority, advertising matter.
2. White Sulphur Spring. Analyst and authority, Winslow Anderson (1889).
3. White Sulphur Spring. Analyst and authority, Curtis and Tompkins (1911).
4. Liver and Kidney Spring. Analyst, G. E. Colby (1887). Authority, advertising matter.
5. Liver and Kidney Spring. Analyst and authority, Winslow Anderson (1889).
6. Liver and Kidney Spring. Analyst and authority, Curtis and Tompkins (1911).
7. Hot Salt Spring. Analyst, G. E. Colby (1887). Authority, advertising matter.
8. Hot Salt Spring. Analyst and authority, Winslow Anderson (1889).
9. Hot Salt Spring. Analyst and authority, Curtis and Tompkins (1911).
10. Black Sulphur Spring. Analyst and authority, Winslow Anderson (1889).
11. Surprise Spring. Analyst and authority, Winslow Anderson (1889).

"The adjacent hills are composed of cherty gravels and other finer sediments that represent marine deposits, but the origin and character of the springs seem to be due to the local formation of a saline marsh. Several unsuccessful attempts have been made to obtain fresh water here. The domestic supply is pumped from a well $1\frac{3}{4}$ miles eastward."

Bibl.: Repts. VIII, p. 163; XII, p. 331; XIII, p. 510.

Ferndale Springs. Two carbonated springs issue from a bank of thick bedded sandstone on the south side of Vaca Cañon about 6 miles south of Martinez. The water from the principal spring is now bottled and marketed by the Richmond Soda Works, 1134 Ohio street, Richmond, R. H. Curry, owner and manager. The natural water is sold in 5-gallon jars for drinking purposes, and it is also used in the preparation of several soft drinks.

Bibl.: Water Supply Paper 338, p. 208.

Sulphur Spring in Pine Cañon.* "A moderately sulphureted spring emerges about 4 miles in a direct line northward from Danville, in Pine Cañon, which is at the western base of Mount Diablo. The water forms a clear pool, about 15 inches wide and 4 feet long, in thick bedded sandstone at the southern side of the creek. The yield is larger than is usual for springs of this class, being estimated at 5 gallons a minute, and the temperature of the water (67°) is also somewhat above the normal. The spring has not been improved, but it has been visited by occasional picnic parties. There are seepages within 5 yards of the spring, and $1\frac{1}{2}$ miles further eastward, upstream, sulphureted water seeps from a bluff on the northern side of the creek. Only one spring of appreciable flow was observed along the cañon, however."

Sulphur Spring Near Walnut Creek.* "A group of sulphur springs lies near the northeastern base of a low ridge about 2 miles northeast of the town of Walnut Creek. The largest spring is on the ridge about 100 yards from its eastern base and 25 yards north of the county road. When the place was visited, the water rose in a board-curbed pool protected by a latticed house and was piped to a cattle trough a few yards away. It yielded about 3 gallons a minute of mildly sulphureted water, 81° in temperature." . . . "Five other smaller springs issue in a belt extending 350 yards along the base of the ridge, in and near the barnyard of Sulphur Springs farm. Two of them have been piped to watering troughs near by. The other three are of seeping flow and form only small marshy places."

"The ridge is composed of sandstone the dip of which is nearly vertical, and strike 5.30° E. (magnetic) along the trend of the ridge. The steep inclination of the beds shows that intense movement has taken place here, and a fault . . . extends along the border of the valley land. This structural break probably accounts for the rise of the springs and also for their thermal character."

QUICKSILVER.

Quicksilver was formerly mined on the east slope of the north peak of Mount Diablo, in section 29, T. 1 N., R. 1 E. During the late seventies the **Ryne Quicksilver Mine** was operated and is said to have pro-

*Water Supply Paper 338, p. 270.

duced as high as 85 flasks a month. The occurrences are very limited in extent and there has been no work done for a number of years.

Bibl.: Rept. VIII, p. 162. U. S. G. S. Mon. XIII, p. 378.

STONE INDUSTRY.

Under this heading are included crushed rock and sand.

The **Antioch Sand Plant** is located 1½ miles east of Antioch in the sand dunes bordering the San Joaquin River. A spur track of the Santa Fe railroad is laid to the property. A 20-h.p. electric motor operates a drag line scraper which empties into the freight cars below the platform. Four 50-ton cars can be loaded daily, only one man being necessary to control operation. The cars are switched by using the electric hoist which operates the scraper. The sand is fine grained and very clean. It is used for mixing with asphalt for road and street work. Owner, E. B. and A. L. Stone Company, 210 Rialto Building, San Francisco.

The **Bates, Boreland and Ayer Quarry,** also known as the old **Stege Quarry,** has been worked for over 20 years. It has been idle since August, 1918, due to lack of construction and street work. The quarry is on the ridge east of Stege, over 1000′ in elevation above the crusher, which is alongside a spur track of the Santa Fe, and adjoining the plant of the Hutchinson Company. The rock is a hard gray metamorphosed sandstone. A gravity tram 4960 feet long brings the rock from the quarry to the crusher. The present crusher was erected three years ago, and has a capacity of 450 cu. yds. per 10 hours. The bunkers below the crusher have a capacity of 3000 yards. Twenty men are employed. Owners, Bates, Boreland and Ayer, Oakland Bank of Savings Building, Oakland. C. D. Bates is manager. The owners formerly operated a quarry in San Pablo Cañon, the rock being used exclusively for the San Pablo Dam project of the East Bay Water Company.

Blake Brothers Quarry. See San Pablo Quarry.

Christen Quarry. This small quarry lies ¼ mile west of Pacheco. The rock is a soft buff-colored sandstone. It was quarried occasionally by the county officials for macadamizing the roads in that district. There is no equipment at the quarry, and it has not been worked for some time. J. M. Christen of Pacheco is the owner.

Bibl.: Bull. 38, p. 316.

Healy-Tibbetts Construction Company. See Point Molati Quarry.

The **Holland Sandstone Brick Company** operates a sand plant 1 mile east of Antioch in the sand dunes along the San Joaquin River. The method of handling is the same as at the Antioch Sand Plant, drag line scraper operated by electric hoist. One man is employed. The company was organized to manufacture a brick from this clean sand, and a large plant was erected. The bricks were not a success and the old plant has been partially dismantled. H. A. Buck, 22 Battery street, San Francisco, is president.

Hutchinson Company. (See Point Richmond and Stege Quarries.)

The **Oakland, Antioch and Eastern Railroad Company** operates a quarry alongside of the railroad near Valle Vista. A light-colored volcanic rock is broken down by blasting and loaded onto the cars by steam shovel. It is used for ballast.

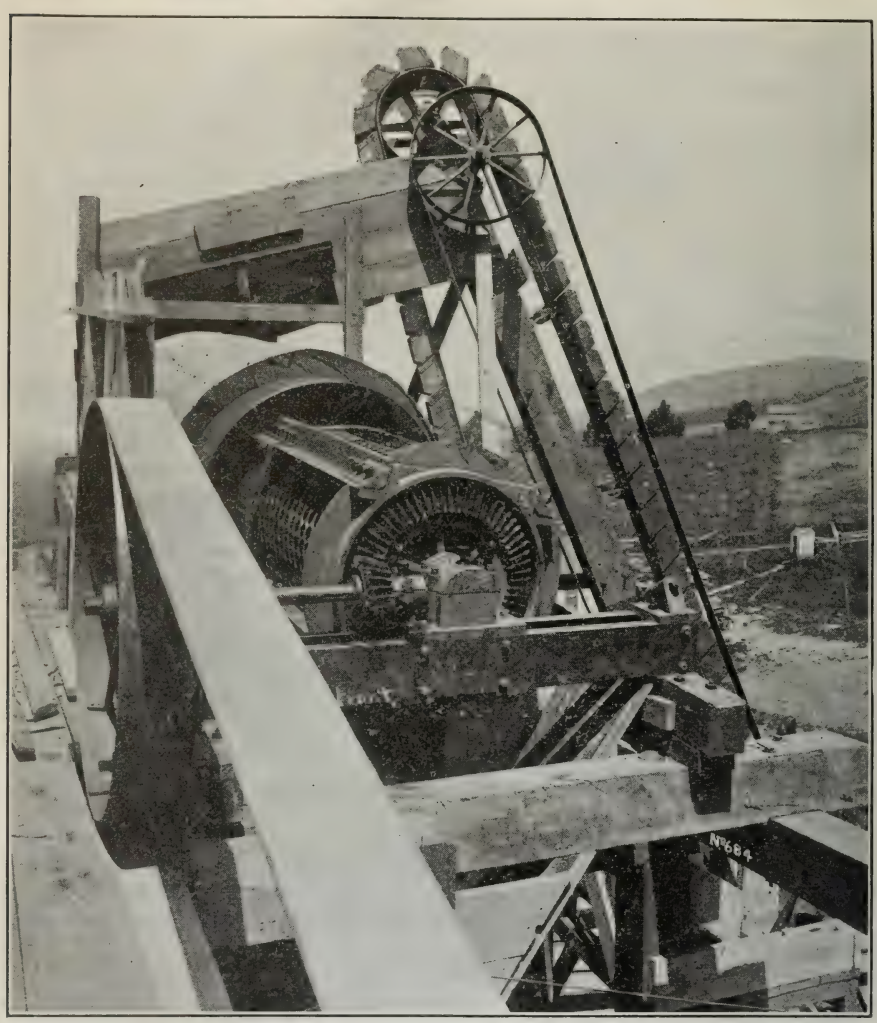

Photo No. 6. Detail of construction at the Bates, Boreland and Ayer Plant, showing arrangement of revolving screens, placed one within the other. Photo by courtesy of Meese and Gottfried Company.

Point Molate Quarry. The quarry is at the edge of San Francisco Bay 2 miles north of Point Richmond. The rock is a hard gray metamorphosed sandstone of the Franciscan formation. It is quarried in a large open cut whose face varies up to 100 ft. in height. Two steam shovels are in operation on the main floor of the crushing plant. In a pit 10 ft. below the main floor, 4 bull-wheel derricks are used to load rock in portable bunkers. These bunkers feed to skips which transport

the rock to the crushing plant. This plant is equipped with two No. 5 and two No. 3 gyratory crushers, trommels, bucket elevators and belt conveyors. It is operated by electric power. Steam power generated with crude oil fuel is used for operating derricks and hoists. Forty men are employed. The rock is used mostly for concrete in San Francisco and vicinity, to which it is shipped in barges at the quarry. Owner, Healy-Tibbets Construction Company, 9 Main street, San Francisco.

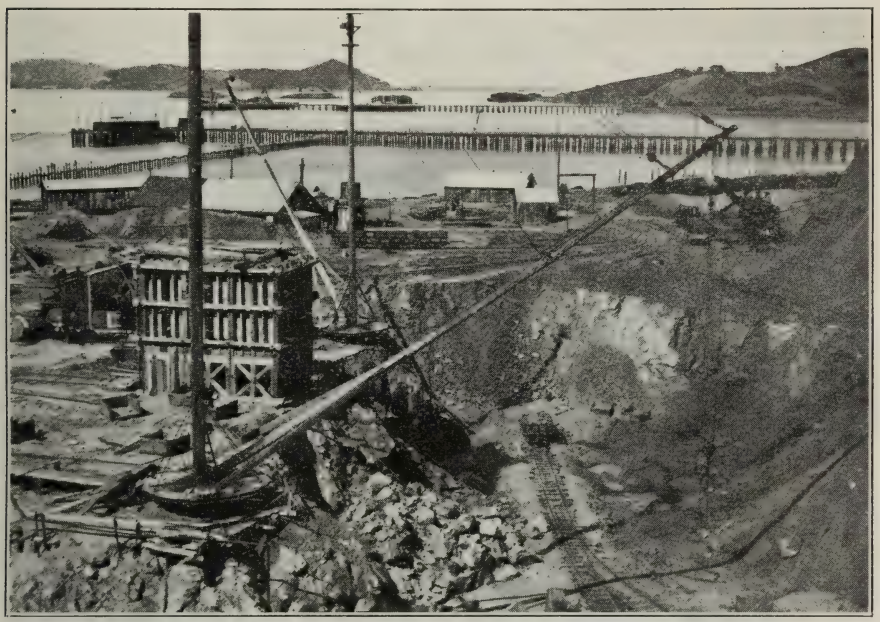

Photo No. 7. Point Molate Quarry looking westward, showing method of handling rock from pit by bull-wheel derricks.

Point Richmond Quarry. The Hutchinson Company, 444 Seventeenth street, Oakland, have been operating this quarry for the past five years. The rock is metamorphosed sandstone closely resembling that of the Point Molate and San Pablo quarries. It is quarried in a large circular open cut whose face is about 85 feet high. Air drills are used. The stone is shoveled into 1¼-yard cars and hauled by cable up an incline to the crushing plant. This consists of one No. 4 and one No. 3 gyratory crushers, bucket elevators and trommels having a capacity of 300 yds. per 10 hours. Electric power is bought of the Pacific Gas and Electric Company. The product can be shipped either by rail or water, as a spur track of the Santa Fe runs within 100 yds. of the plant. The best rock is used for concrete, and the poorer quality for ballast. Mr. Smalley is superintendent.

The San Pablo Quarry, also known as **Blake Brothers Quarry,** is at the edge of the San Francisco Bay about 1 mile north of Point Richmond, on the same range of hills as the Point Molate and Point Richmond quarries. The quarry is a circular open cut, approximately 480′ in diameter, having a face of 296′ in height at the highest point. The deposit here is very regular, consisting of a hard, gray siliceous sand-

stone. Steam locomotives haul the rock in 3½-yd. bottom dump cars of special design, to the 1000-yd. capacity crushing plant at the edge of the bay. Twelve cars are hauled per trip, and two locomotives are in constant use. A third is kept at the plant for emergencies. An Osgood steam shovel is used at the quarry.

The crushing plant, which has been in operation since 1907, was built in 2 parallel units, so that each may be operated independently. There are two No. 6, one No. 4 and two No. 3 gyratory crushers, four 15′ trommels and two 16″ belt conveyors 1240′ long, equipped with an automatic tripper for conveying the crushed rock to the storage bins. Tunnels

Photo No. 8. San Pablo or Blake Brothers Quarry. The face is almost 300 feet high.

have been built under the two bins, to house the belt conveyors that load the barges. These belts are 22″ wide and 1480′ in length. They load barges at the rate of 120 tone in 17 minutes. Electric power is used to operate the plant, 400 h.p. being required when running to full capacity. Each unit is driven by a separate motor. The storage bins have a capacity of 5000 cubic yards. A spur track of the Oakland Traction Company (electric) runs alongside the bunkers. Owner, Blake Brothers Company, 705 Balboa Building, San Francisco; Anson Blake is president; Edwin Blake, secretary; and J. Asmussen, superintendent at plant.

Slater Quarry. This quarry is situated ½ mile south of Pacheco. It is on the same ridge as the Christen quarry and the deposit is evidently a continuation of the same soft friable sandstone beds. The rock

was used occasionally for macadamizing roads in the vicinity, but the quarry is now idle. There is an outcrop of white limestone overlying the sandstone. This has not been developed and the cropping is small. A. E. Slater of Pacheco is the owner.

Bibl.: Bull. 38, p. 317.

Mrs. J. F. Scheller of Antioch owns a sand plant adjoining that of the Holland Sandstone Brick Company. A drag line scraper loads the sand directly into flat cars on a spur track of the Santa Fe, which runs into the property. When visited (May, 1919) the gasoline engine, which ran the scraper, was being removed and a 20-h.p. motor installed in its place. The sand is shipped to Oakland and San Francisco for use in asphalt pavements.

Stege Quarry, Hutchinson and Company, 444 Seventeenth street, Oakland, owner. The quarry is on the west slope of the Berkeley Hills, opposite Stege Station. A spur track of the Santa Fe runs up to the bunkers below the quarry. The rock is a metamorphosed sandstone. It is quarried in a large semi-circular open cut whose face is about 300 ft. high and about 300 ft. across. Three gyratory crushers, two No. 5 and one No. 3, handle all the rock, the capacity of the plant being 600 yds. daily. It is operated by electric power supplied by the Great Western Power Company. Fifteen men are employed. The rock is used for macadam and concrete purposes. Dwight Hutchinson is president of the company, and Hardy C. Hutchinson, secretary; W. R. Williams is superintendent at the plant.

MISCELLANEOUS CHEMICAL WORKS, COMMERCIAL PLANTS, ETC.

The Butters Electrolytic Zinc Syndicate have recently completed a plant about 2 miles east of Martinez, for the electrolytic refining of zinc ores and concentrates. The plant is located at Peyton Station on the main line of the Southern Pacific Railway. When visited, May, 1919, a few test runs had been made and final adjustments were under way. Ore and concentrates from the Afterthought copper mine in Shasta County were to be treated soon, and it was planned to treat custom ore later. The process consists of roasting in an open hearth furnace, and then leaching with sulphuric acid (H_2SO_4). The copper is first precipitated from the solution with zinc dust, and the metallic zinc is obtained by electrolysis.

The capacity of the plant will be about 3 tons of zinc metal per day. Twenty men are employed. A. V. Udell is superintendent and part owner. It is understood the plant is owned, in partnership, by five persons. Home office, Charles H. Butters, 6400 Chabot road, Oakland.

The **General Chemical Company** have an extensive plant at Nichols, about 2 miles east of Bay Point, on the shore of Suisun Bay. The products are the mineral acids, pyrite from Shasta County being used for their production. Between 300 and 400 men are employed. W. H. Nichols, Jr., is president of the company; home office at 25 Broad street, New York.

The **Giant Powder Company,** located at Giant, on the edge of San Pablo Bay, a few miles north of the city of Richmond, on the Southern Pacific Railroad. Principal product is blasting powder.

The **Great Western Electro Chemical Company** operate a large chemical plant about 1 mile east of Pittsburgh. The principal products are liquid chlorine, caustic soda, chloride of lime, and carbon tetrachloride. During the war the government took over and operated the chlorine plant. The electrolytic process is used in the manufacture of caustic soda. The carbon tetrachloride is the principal ingredient used in the manufacture of fire extinguishers.

Salt is the main crude material used and is obtained from works at Alvarada and Mount Eden. Lime is obtained from the Pacific Lime and Plaster Company at Sonora, Tuolumne County, and carbon bisulphide from the Stauffer Chemical Company.

The works are controlled by the Fleishhacker interests. W. H. Lowery is president; home office at 9 Main street, San Francisco.

Hercules Powder Company. Located at Hercules on the main line of the Southern Pacific Railroad, just north of the town of Pinole, and on the east shore of San Pablo Bay. Iron pyrites is used for the production of sulphur and sulphuric acid (H_2SO_4), about 50 tons of the latter being produced per day. The sulphuric acid is used for the manufacture of nitric acid (HNO_3) and other mixed acids which in turn are used in the manufacture of blasting and other kinds of powder.

Mountain Copper Company operates a large smelter on the south shore of Suisun Bay, about 1 mile northeast of Martinez. In connection with the smelter there is also a sulphuric acid plant and a plant for the manufacture of "Mococo" fertilizer. Built in 1905, it has been in operation almost continuously for the last 14 years. Recently (April, 1919) most of the plant has been closed down, owing principally to an over supplied copper market. When operating to capacity, between 150 and 200 men are employed. The main smelting equipment consists of 2 reverberatory furnaces, one 90-foot and one 60-foot; 2 stands of converters; 3 roasters, etc. The capacity is from 300 to 350 tons of crude ore daily, which yields from 10 to 15 tons of blister copper.

A great deal of ore comes from the company's mines in Shasta County, but some custom ore is also treated. The material consists of raw sulphides and siliceous ores, flotation copper concentrates, and roasted sulphides.

Both electric and steam power is used, a total of 500 horsepower being consumed. The slag has a value of 50c per ton for railway ballast, concrete aggregate, etc.

In the fertilizer plant, a phosphate rock obtained from Idaho is treated with sulphuric acid.

Home office is at 332 Pine street, San Francisco; T. B. Swift is superintendent at the plant.

The **Pacific Electro Metals Company,** until quite recently (the latter part of 1918) operated an electric smelter at Bay Point, for the production of the ferro and silico-alloys. The recent slump in the chrome and manganese market forced the plant to close. It has since (June, 1919) been taken over by the **Pacific Alloy and Steel Company,** who intend to begin operations soon.

The plant was designed by the Beckman and Linden Engineering Corporation, 593 Market street, San Francisco.

There are two large electric furnaces, each having a capacity of 12 tons of silico-manganese daily. Silico-manganese was the principal product, but some ferro-manganese was made.

Several additional furnaces of smaller capacity have been built, and it is expected that ferro-chrome, ferro-nickel, ferro-tungsten, and ferro-molybdenum will be made. The main furnace building is of reinforced concrete, 120 x 50 feet. The electrodes for the two large furnaces are 24 inches in diameter, hexagonal in shape and 7 feet long. Trouble was experienced at first in getting electrodes. A plant was erected in which these were made from lampblack residue from local gas plants.

The charge is shovelled around the electrodes and metal is tapped from the bottom, the process being continuous. In making silico-manganese, an ore carrying not less than 40% manganese and not over 20% silica is used, but one carrying 36% manganese and not over 18% silica could be used. The charge consists of ore, coke and iron turnings up to 3″ in diameter. Some of the coke used has been made locally from residue of California oil refineries. The silico-manganese produced carries 50% to 55% manganese, 20% to 25% silica, less than 1% carbon, not over .18% phosphorus and trace of sulphur.

This plant provides a market for such products as gas plant lampblack and crude oil residue coke, which have heretofore been of little or no value.

In relation to the above, it may be interesting to note that the Beckman and Linden Engineering Corporation have completed (June, 1919) the construction of a 1000-k.w. electric furnace at their laboratories, 41 Minna street, San Francisco. This will be used entirely for experimental purposes, and it will be at the disposal of any one interested in electric smelting processes. It is understood that there is only one other furnace of this kind in the United States, and that is at Niagara Falls.

The **Selby Smelting and Lead Company**‡ have for many years operated a large custom smelter at Selby, on the edge of San Pablo Bay, a few miles south of Vallejo Junction. This is claimed to be the largest smelter producer of gold in the United States, and employs several hundred men throughout the year. It is situated on the main line of the Southern Pacific Railroad, and hence receives ore shipments by both rail and water. Ores treated are principally those of gold, silver and lead, which come from all the Pacific Coast States, but principally from Nevada and California.

The plant represents an investment of approximately $4,000,000 and includes a 400-ton smelter, with lead stacks, a 200-ton lead reverberatory furnace, a refinery for parting lead and silver, a bag house having the Cottrell process for purifying the fumes, and a plant for the manufacture of bluestone.

The home office is in the Merchants' Exchange Building, 465 California street, San Francisco; H. B. Underhill, Jr., is president.

The **Union Super-Phosphate Company** have a plant at Stege, where phosphate rock, obtained from Wyoming, Idaho, and the Pacific Islands, is treated with sulphuric acid for the production of superphosphate. This is used by the Pacific Guano and Fertilizer Company, a subsidiary concern located in West Berkeley, for the manufacture of fertilizer. About 25 men are employed.

Mr. Kuch is superintendent at the plant; home office, 343 Sansome street, San Francisco.

‡Described in detail by T. A. Rickard, in the Mining and Scientific Press, April 8, 1916, Vol. 112, No. 15.

FRESNO COUNTY.

Fresno County has an area of 5977 square miles, or nearly three times that of the State of Delaware. It is bounded on the east by the summit of the Sierra Nevada Mountains, along which line there are numerous peaks exceeding 13,000 feet in elevation. The western boundary of the county is marked by the Diablo Range. It is traversed by several electric power lines, two transcontinental railroad systems and six oil pipe lines. Its total mineral production for 1919, the last year for which complete figures are available, amounted to $21,643,898. The products in order of their value were petroleum, natural gas, miscellaneous stone, brick, granite, magnesite, gold and silver. In addition occurrences of many other minerals are known which have not as yet been commercially developed.

A detailed description of the mineral resources of Fresno County is contained in the Fourteenth Report of the State Mineralogist, printed in 1916, to which the reader is referred for more complete information than that presented in the following brief notes.

ASBESTOS.

Asbestos has never been produced in this section of the state to date, although deposits have long been known to exist in the foothills of the Sierra Nevada boundary north and east of Sanger. Early in 1920 the Pioneer claim, upon which this mineral had been discovered, was located by S. M. Mingus, Arthur Lewis and D. M. Caley. This claim is situated about three-fourths of a mile west from the Archer quicksilver mine, 28 miles northwest of Coalinga, in the White Creek district.

BRICK AND CLAY.

Craycroft Brick Company. F. J. Craycroft, president; office 407 Griffith-McKenzie Building, Fresno. The plant of this company is located at Crayold Siding, 3 miles west of Fresno. This plant, which was built in 1911, has a daily capacity of from 50,000 to 60,000 brick. Considerable amounts of clay are shipped in from a deposit five miles south of Merced and mixed with the local clay which is obtained from a superficial valley deposit about five feet thick. It is loosened by scrapers and trammed to the mill where it is ground and passed through a stiff mud machine. Ten to forty men are employed at various times during the year, according to the market demands. The present outlook of the business is very good.

Prescott Brick and Lumber Company. Successors to Fresno Brick and Tile Company. E. M. Prescott, manager; Rowell Building, Fresno. This company formerly operated a plant at Mars Siding, about 1 mile southeast of the city limits. At the present time no brick is being manufactured locally, the product handled being obtained from the S. P. Brick Company at Exeter, in Tulare County.

CHROMITE.

During the war a great deal of prospecting for chromite was carried on in Fresno County and many valuable deposits were uncovered. One of the principal belts of this material occurs near Sentinal in township

11 S., R. 23 E., running in a northwest and southeast direction. During 1920 this branch of the mineral industry was dormant. Complete details relative to deposits have been printed in Bulletin No. 76, entitled "Manganese and Chromium in California."

COAL.

Fair sized deposits of coal, upon which some development work has been done in the past, are located near Coalinga and in Priest Valley, near the junction of Fresno with San Benito and Monterey counties. No production has been done on these coal beds since 1896. The impending shortage of oil, however, has revived interest in our coal resources and it is quite possible that renewed activity will be noted here in the near future.

COPPER.

The southern extremity of the foothill copper belt of the Sierra Nevada reaches for some distance into Fresno County. A great many mines and prospects have been worked along this belt in the past, although absolutely no activity was noted during the past year. Full details relative to this subject are contained in the Fourteenth Report of the State Mineralogist. At the time the property of the Fresno Copper Mines near El Prado was visited (May, 1920), the 400-ton smelter was being junked.

GOLD.

Gold mines and prospects are widely disributed throughout the eastern portion of Fresno County. On account of economic conditions, which have seriously retarded this branch of the mineral industry throughout the State, these mines were practically all idle during the year just closed. The only production of this metal noted was that of the Grant Rock and Gravel Company, at Friant, which produced sand and gravel, primarily for use in concrete and other construction work. The material dug from their gravel pit is washed and passed over Hungarian riffles and considerable gold is recovered as a by-product. A complete description of this company's operations is given under the heading of "Stone Industry."

MAGNESITE.

Magnesite is of frequent occurrence in the serpentine areas of California. The principal deposits of the state are located in the Coast Range Mountains, but large quantities are also found in the foothills of the Sierras, particularly in Fresno and Tulare counties. There was great activity in the production of this mineral during the war, but with the drop in prices a great deal of the former development work was brought to a standstill. With the closing of the calcining plant operated by Sinclair Brothers at Piedra in May, 1920, it is believed that production for Fresno County ceased entirely.

PETROLEUM.

The entire oil producing area of Fresno County is centered in the Coalinga field, where activities were first commenced in 1890. In the early days of this industry Fresno was the leading county of the state and it now takes second place only to Kern, both in point of annual

yield and in total amount produced to date. Details relative to this subject will not be entered into here, as they are available at great length in other publications, both of the State Mining Bureau and the U. S. Geological Survey. During the past year renewed efforts have been made to develop oil and gas, both in the western and the central portions of the county, but so far without success.

QUICKSILVER.

There has been no activity during the past year in quicksilver mining in this portion of the state. For complete details as to development and possibilities, see Bulletin No. 78, entitled "Quicksilver Resources of California," published in 1918.

STONE INDUSTRY.

Academy Granite Company. F. M. Blanchard, Academy, owner. This quarry is in section 13, T. 12 S., R. 22 E., 11 miles northeast of Clovis, on the Southern Pacific Railroad. The stone is locally known as "black granite." The color permits of a fine contrast of polished and unpolished surface, which makes it excellent for monumental and decorative purposes. It is medium grained and is harder than many of the lighter granites produced nearby. Formerly dressing and polishing of this stone was done at the quarry, but since November, 1918, the entire production has been shipped in the rough state to the Raymond Granite Company at Raymond, Madera County, where it has been finished. The business outlook is very promising. Since the Fourteenth Report of the State Mineralogist was written, operations at this quarry have uncovered a granite ledge twenty to thirty feet thick, striking in a northerly and southerly direction. From this ledge the rock obtained is of even better quality than that produced from the surface boulders.

California Road and Street Improvement Company. Roosevelt and Divisadero streets, Fresno. This company is still active, but the gravel bed formerly operated three miles southwest of Friant has been abandoned.

Doyle and Ghilotti Company. Successors to Gill and Doyle. This company operates a small granite quarry 11 miles northeast of Clovis. At the cutting sheds at Clovis pneumatic tools are employed, electricity furnishing the power. The product is retailed by the Fresno Marble and Granite Works, 2325 I street, Fresno, where cutting yards are also maintained.

Fresno Rock Products Company. C. W. Wood, president, F. R. Brisley, secretary; office, 400 Bank of Italy Building, Fresno. Plant at Woodrock on the Atchison, Topeka and Santa Fe Railroad. This company operates a rock crusher of 500 tons daily capacity, utilizing surface gravel and boulders principally, which are handled by a Hadsel type drag line excavator. Electric power is used. Twelve men employed.

Grant Rock and Gravel Company. Successors to San Joaquin Rock and Gravel Company; A. C. McMillan, secretary and manager, 328 Cory Building, Fresno; plant at Friant; H. W. Jones, superintendent.

Gravel pit. This pit formerly was circular in form, covering some 13 acres of ground. The gravel deposit is from 25′ to 35′ in depth, con-

sisting of gravel ranging from 5″ in diameter down to sand, is well graded, loose and very clean. Over the surface is a deposit of soil commonly known as strippings, reaching to a depth of 3 feet on the average.

Operations are now being carried on with 2½-yard Atlantic shovel and varying from the circular pit to a fantail shape wherein the track can be laid in a straight line from the hopper to the end of the pit.

The property covers some 400 acres of which the pit excavation to date covers about 16 acres. The material is trammed with a 40-ton Climax locomotive from the shovel to the mill hoppers into three and four 12-yard Western side-dump cars. A 35-h.p. motor with direct connected pump takes the water from the pit sump back to the washing plant for the purpose of draining the pit in wet weather and supplying an additional amount of water for washing purposes.

Mill. The mill consists primarily of two 40″ x 18′ scalping screens with 2½″ round perforations. All the material passing through these screens is carried by a 28″ conveyor direct to the washing plant. The rejections from 2½″ to 3½″ in diameter pass to a 36″ horizontal Symons disc crusher. Anything larger than 3½″, which is only about 2% of the total material, passes to a 24 x 13 Farrell jaw crusher, then a conveyor carries the material from both these crushers to another cylindrical screen 40″ x 8′ with 1½″ rd. pfd., the rejections of which are returned to the original scalping screens. All the material is first dumped into four concrete hoppers and fed by four M. and G. reciprocating pan feeders to a 30″ belt conveyor and thence to the original scalping screens.

The crushed material from the crusher passing through the secondary screen goes to a 36″ Symons crusher closely set, hence to a bucket elevator and then to a small screen which divides the crushed rock into 1″ to ⅜″ and from ⅜″ to dust. This is the crushed rock production for Waranite topping and pipe work.

Washing plant. From the mill scalping screens all material passing the 2½″ round perforations falls to a 28″ conveyor, 200′ centers, and is carried to the top of the washing plant. At this point water is supplied by a 6″ pump from the pit and a 7″ pump from the San Joaquin River, 1000 gallons in all. The river water is used as sprays, one in each conical screen. The material is carried first to two conical revolving screens having a 1½″ rd. pfd. All rejections is for highway and large foundations. The next conical screen has 1″ rd. pfd., the next conical screen has ¾″ rd. pfd., the next conical screen has ½″ rd. pfd., and the final conical screen has ¼″ rd. pfd. All material passing through this last screen goes to a large sand wash wherein coarse and fine sands are obtained. In other words, a clean washed gravel is made, 2½″ to 1½″, 1½″ to 1″, 1″ to ¾″, ¾″ to ½″ and ½″ to ¼″. The pit run is well proportioned in size to evenly carry the demand as requested.

Track system. The track system is laid out in such a manner that 70 cars can be fed to the mill and loaded and passed on to the pulling track by gravity. The track is so laid out that 5000 cars of material can be placed in storage with a 20-ton Brown hoist locomotive crane.

Equipment. The plant is supplied with a blacksmith shop having a drill press, lathe, forge and small compressor. A large supply of materials is always kept on hand in the storeroom. Cottages are arranged on the banks of the river under the shade trees in sufficient

number to insure the operating of the plant with married men. There is also a boarding house in which 50 men can be fed. This is run by the company. During the rush season from 35 to 40 men are carried on the payroll.

Gold. Between the last screen on the washing plant and the sand bunker a type of Hungarian riffle has been installed over which all

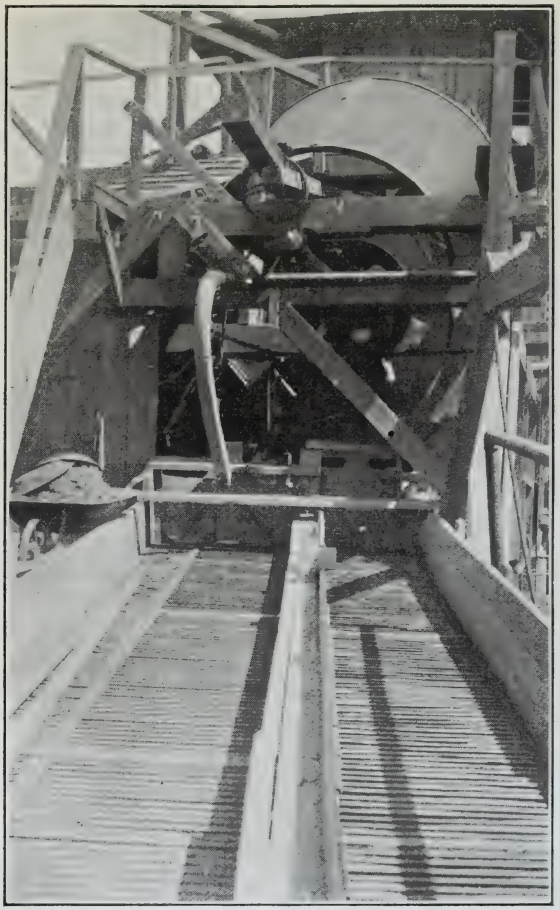

Photo No. 9. Revolving trommel and Hungarian riffles at plant of Grant Rock and Gravel Company.

of the sand must pass, in which there is a deposit of quicksilver, and from $500 to $1,500 in gold is recovered per month. The gravel on a whole runs about 1½ cents per cubic yard.

Capacity. The plant capacity is 70 cars, or 3500 tons, in nine hours. The average production this year has been about 2500 tons per day.

Kings River Quarry. Atchison, Topeka and Santa Fe Railway, owner. Leased to Sharp and Fellows, contracting company, Central Building, Los Angeles. This quarry is in section 8, T. 13, S., R. 24 E., on the Kings River, at Piedra. It was first opened in 1910 and has

been continuously operated ever since. With the exception of minor details a description contained in the Fourteenth Report holds true today.

OTHER MINERALS.

In addition to the mineral deposits mentioned in the foregoing, the records of the Bureau show that the following substances, all of potential value, but inactive in 1920, occur in the district under discussion: Feldspar, fuller's earth, gems, graphite, gypsum, infusorial earth, limestone, marble, mineral water, tungsten and volcanic ash.

GLENN COUNTY.

Glenn County lies in the Sacramento Valley on the west side of the Sacramento River. The Coast Ranges penetrate the western boundary but the greater portion of its 1400 square miles of area is composed of the nearly level valley floor. This rises gradually toward the western ranges and forms a drainage system tributary to the Sacramento River. Agriculture and stock raising are the principal resources.

The commercial mineral production of the county has been confined to brick clay, chrome, manganese, sand, gravel and crushed rock. Occurrences of coal, copper, gold, granite, marble, mineral water, natural gas, petroleum, quicksilver, slate and soapstone have also been noted and described in the Fourteenth Report of the State Mineralogist. Bulletin No. 76 describes the manganese and chrome deposits.

Table of Mineral Production.

Year	Amount	Value	Substance
1893 and previous	3,319 long tons	$49,700	Chrome
1909	140,000 tons	49,000	Macadam
1910	378,000 tons	34,020	Rubble
1911	421,775 tons	51,430	Sand and gravel
1912	543,675 tons	32,950	Sand and gravel
1913	416,640 tons	27,776	Sand and gravel
1914		30,553	Stone, miscellaneous
1915	746 lbs.	131	Copper
		46,526	Stone, miscellaneous
		10	Other minerals
1916		41,180	Stone, miscellaneous
		39,982	Other minerals
1917	879 tons	21,474	Chromite
		9,721	Manganese
	369 tons	33,260	Stone, miscellaneous
		817	Other minerals
1918	1,129 tons	57,263	Chromite
		32,436	Stone, miscellaneous
1919		58,137	Stone, miscellaneous
		1,500	Other minerals
Total value		$617,863	

During the year 1920 there was no mining activity in the county with the exception of the sand, gravel and stone industry.

SAND AND GRAVEL.

County Gravel Pits. The county opened up four new gravel pits situated as follows: SE. ¼ section 4, Glenn Ranch Survey; NE. ¼ section 12, T. 20 N., R. 3 W.; NW. ¼ section 29, T. 20 N., R. 3 W.; NE. ¼ section 6, T. 19 N., R. 3 W. The material is used on road work.

Green and Williams Pit. (Formerly **Donohoe.**) In November, 1919, Green and Williams of Orland opened a gravel pit in the bed of Stony Creek, one mile north of Orland. The state highway passes the pit and a spur track connects with the Southern Pacific main line at Wyoming.

Gravel is taken from the creek bed by a steam drag-line dredger with 1 cu. yd. bucket. Bunkers have been constructed so that the material can be loaded direct to cars. The plant is equipped with

jaw crusher, trammel screen, pump and washing outfit, and a clean crushed gravel suitable for concrete work is produced as well as "bank run" for ballast, etc. Four men are employed. Crude oil is used for fuel. The owners report a good demand for the crushed and washed product.

Stony Creek Gravel Pit (Wyo Pit), owned by the Southern Pacific Company. Operations have continued steadily throughout the year.

Willows City Pit. This property has been sold to Garnet Black of Willows. The city now obtains its gravel from the county pits.

In addition to the above, the State Highway Commission erected temporary loading and screening plants in creek beds at various points, and used the gravel on highway construction and repair work. The gravel in the creeks is all fairly clean and free from clay.

PETROLEUM.

Considerable interest has been manifested during the year in regard to oil in Glenn County. On the **O. P. Wiggins Ranch,** 13 miles west of Orland, the owner reports that he can set the ground on fire at several places. A report on the possible occurrences of petroleum in this county is contained in Bulletin No. 89.

KINGS COUNTY.

With the exception of the Kettleman and Kreyenhagen Hills, and a small portion of the Diablo Range at its southwest corner, Kings County is almost entirely a valley county. For this reason its mineral resources are not prominent.

The most notable geographical feature of this county is Tulare Lake, which in times past has had a water area of as much as 400 square miles. At the present time, however, the lake is entirely dry, and most of the land included in its former boundaries is under cultivation.

CHROMITE.

Chrome float has been found in the serpentine area at the southwest quarter of Kings County, but active development work has never yet been undertaken.

CLAY.

Two brickyards were formerly in operation near the town of Hanford. Both of these have been dismantled and abandoned, however, and no clay is being commercially utilized at the present time in the entire county.

FULLER'S EARTH.

Two deposits of Fuller's earth are described in the Fourteenth Report, one in township 24 S., R. 17 E., and the other in township 21 S., R. 17 E. When this county was visited by a representative of the Bureau in May, 1920, neither of the owners of the above deposits could be found, and apparently no development work had been carried on for some time.

GYPSUM.

It is reported that a small amount of gypsum was produced in 1913 from a deposit in section 13, T. 24 S., R. 17 E., northwest of Dudley. No further information relative to this deposit has been obtained.

MINERAL PAINT.

The occurrence of mineral paint was noted in the above-mentioned deposit of gypsum. This deposit also remains idle.

NATURAL GAS.

Considerable quantities of natural gas has been obtained from a number of artesian wells for many years near the towns of Corcoran, Angiola and Stafford. A list of the owners of these wells can be found in the Fourteenth Report. In addition to these wells, it is interesting to note that the possibility of developing commercial quantities of natural gas in this portion of the San Joaquin Valley is suggested by recent drilling conducted by the Natural Gas and Petroleum Company. Their well is in section 12, T. 23 S., R. 22 E., about five miles southwest of Angiola. The owners of the well have authorized no statement as to the amount of gas developed nor of the drilling conditions. Creditable current reports, however, indicate that gas in considerable quantities and under considerable pressure has been found. The well is close to one drilled by Dudley Brothers in 1918.

PETROLEUM.

There are two strips of possible oil-producing territory in the Kettleman and Kreyenhagen Hills, running through Kings County, between the Coalinga district on the northwest and the Lost Hills district on the southeast. A number of companies have been and are drilling this section. For a detailed description of the geology and possibilities of this district, see Bulletin No. 69, entitled "Petroleum Industry of California."

QUICKSILVER.

A number of quicksilver occurrences have been discovered in the southwestern corner of Kings County, where it adjoins Fresno and Monterey counties. Parkfield, Monterey County, is the only town in the district. These deposits have been described in detail both in the Fourteenth Report and in Bulletin No. 78.

The Bureau has recently been advised that the **Patriquin Brothers** of Parkfield have taken over the **Dawson Mine** which was formerly owned by H. Dawson of Lemoore, and that they also control the **Fairview Group,** formerly owned by G. H. French and J. A. Greenlaw of Parkfield, as well as the **Segregation** and **Summit** claims, in section 20, T. 23 S., R. 16 E., which in the earlier reports were recorded as being owned by Mr. C. A. Francis, and under bond to the Kings Quicksilver Mining Company, 520 Kings street, London, Ontario, Canada. According to newspaper reports, early in December, 1920, a new company of Canadian owners have taken over the entire holdings of the Kings Quicksilver Mining Company at Parkfield. C. C. Jones, of Toronto, is the new manager.

SAND.

A. M. Casella, Hanford, operates a small sand pit about 1 mile south of town on the Corcoran road. This material has only been produced in small quantities, all of which has been sold locally.

LAKE COUNTY.

Lake County is bounded on the north by Mendocino and Glenn; on the east by Glenn, Colusa and Yolo; on the south by Napa; and on the west by Sonoma and Mendocino. It is one of the most picturesque counties of the state and is noted for its interesting geological features and numerous mineral springs. Besides mineral water, Lake County has in the past been a noted producer of quicksilver. Other mineral occurrences include chromite, manganese, borax, clay, copper, gems, gold, gypsum, silver, sulphur, natural gas and miscellaneous stone.

Its mineral resources have been described in the Fourteenth Report of the State Mineralogist and special mention of the quicksilver mines of the county will be found in Bulletin No. 78. Bulletin No. 76 describes the manganese and chrome deposits. Changes and corrections are noted here, supplementing and bringing up to date the data already published.

CHROMITE.

None of the chrome mines described in Bulletin No. 76 were working during the present year. There is no railroad traversing Lake County and since the war chrome mining has not been a profitable venture in this county. William Taylor, of Upper Lake, has a chrome prospect on Bartlett Mountain, south of Eel River. There is no road to the property and it is undeveloped.

COPPER.

Copper Prince Mine. Idle. H. C. Betts, former owner, deceased.

MANGANESE.

Manganese was produced in Lake County in small amounts during the war period, but there has been little activity the past year. Of the deposits mentioned in Bulletin No. 76, the most important, the Van Ranch deposit, is worked out, and the others are idle. The following properties have been developed since the publication of Bulletin No. 76, and with improved market conditions there is a possibility of further production in the near future.

Old Dough Claim. This deposit was discovered in 1919 by J. E. Rees of Middletown and one claim, the Old Dough, was located in 1920. It is situated in T. 12 N., R. 9 W., and lies at an elevation of 2700 feet. The nearest railroad station is Calistoga, 30 miles by good road, which passes within a short distance of the claim. There is a good water supply at hand. The deposit is said to be large and most of it low grade. A few high grade bunches occur. It is undeveloped, but the owner expects to do some work before the end of the year.

Phillips Manganese Mine. This mine is located near the top of a high ridge on the Phillips ranch about 1½ miles south of Laurel Dell. A high grade lens of manganese was opened up here and it was one of the first producers in Lake County, about 100 tons having been shipped out before mining ceased. All the ore was packed out on mule-back, as there was nothing but a trail to the mine. Considerable ore of good grade was left piled on the dump. There is an open cut about 60 feet long which intersects several narrow veins and cuts the main

lens at a depth of 30 feet. The general strike of the ore body is nearly north-south and it dips about 60° westerly with the slope of the hill. Good ore is exposed in the bottom and at various points on the sides. Ore so far produced is said to have averaged better than 50% manganese and less than 8% silica. The Suydan Company of San Francisco have taken a lease on this property; Wm. Fales, superintendent. At the time of visit, five men were employed building a sled road from the mine to the road near Laurel Dell. From here it can be taken by auto trucks to the railroad at Ukiah for $5 per ton. Production is expected to begin as soon as the sled road is completed.

Smythe Manganese Prospect. T. A. Smythe of Middletown has a lease on 160 acres of the Ormsby Ranch on which there is a deposit of manganese ore. The property is on a branch of Dry Creek, about 3 miles west of Middletown in township 10 N., R. 7 W. A good road runs within ½ mile of the deposit. The deposit was discovered in 1918. It outcrops high up on the abrupt side of a hill, the elevation being about 1800 feet. There is scrub oak and pine on the hills.

One vein, or lens, of good grade has been exposed and proven on the surface for 30 to 40 feet. It has a width of 2½ to 3 feet and strikes nearly north-south, dipping into the hill at an angle of 45°. The country rock is sandstone and jasper. Two or three tons had been taken out at the time of visit in doing prospecting work, but it was not sufficient to indicate the extent of the ore body.

MINERAL WATER.

Anderson Springs. Now owned by Miss Rose Anderson. Extensive improvements are contemplated at this well known resort.

Bartlett Springs. Owned by the Bartlett Springs Company; C. C. McMahan, president; H. J. Mathews, manager at the springs. Stages run from Williams on the east side and from Hopland on the west side. Additions and improvements have been made from year to year. Water bottled at the springs is passed through a Berkfeld filter. Block tin lined crowns are used instead of the former crimped caps. Artificially carbonated Bartlett water, formerly bottled in San Francisco, is no longer on the market. Five ton auto trucks have replaced the twelve-mule teams formerly used to haul the bottled water to Williams.

Bonanza Springs. Under lease to James F. Mast. The "Magnesia" spring (a well) went dry during the present season.

Bynum Spring. Bottling has been discontinued at this spring.

Castle Hot Springs. Owned by the Crescent Investment Company, Oakland, California; M. P. Morgan, manager at the springs.

Harbin Hot Springs. Owned by the Mathews Estate and under lease to N. S. Booth. A second steam bath has been added and another hot sulphur spring was opened up in 1918.

Highland Springs. Now reached by stage from Hopland. The water is being tested for radio activity, but no report had been received at the time of visit.

Howard Springs. Owned by M. J. and Wm. J. Laymance of Oakland, California; Chas. E. Stark, lessee.

Newman Spring. This property is not leased at the present time.

Saratoga Springs. E. K. Keil, owner. This property was taken over January 8, 1920. A cement plunge has been added and other improvements furnish accommodations for guests.

The extremely dry season has had little appreciable effect upon the flow of mineral springs, according to reports from owners, but many of the resorts have had difficulty in getting a normal supply of fresh water, due to diminished flow of fresh water springs and wells.

NATURAL GAS.

Natural gas which rises through the water of Thurston Lake is utilized for lighting and cooking purposes at the Lodge of R. D. Foye of San Francisco, owner of the property. Thurston Lake is a small body of water without an outlet situated about four miles west of Lower Lake, near the southern end of Clear Lake. Five gas springs near the shore line have been capped. The gas is collected and led by pipe to the gasometer above the lake, near the lodge. This holder is six feet in diameter and seven feet high. The five springs supply gas for from fifty to sixty lights using Welsbach mantles and for three kitchen ranges. It also is used to operate a 2 horse power engine which drives a pump for raising water from the lake to the lodge buildings.

In ordinary years all five springs are under water, but during the summer of 1920 only one cap was over the water, the other four being on the shore close to the water's edge. Twenty-nine other gas springs have been counted in the lake. These are easily recognized as the gas bubbles up through the water, especially when the surface is quiet. The lake has an average depth of twenty feet, but in the vicinity of the gas springs, which are roughly arranged in a circular form, it is about forty feet deep. Volcanic rocks and pumice occur along the shore and it is thought that very fine pumiceous material and volcanic dust kept in agitation in the lake water by the action of the gas gives the water its distinctly muddy look. The water is soft and good to drink, having a taste resembling rain water. In the kitchen ranges the gas burns with a clear blue flame. It is said to rate 921 B. t. u.

PETROLEUM.

The occurrence of natural gas at Kelseyville, and at Thurston Lake as noted above, together with the occurrence of small amounts of paraffine oil in some of the quicksilver mines, has led to speculation in regard to the possibilities of oil production in the county. Bulletin No. 89, now in preparation, covers this subject in detail.

QUICKSILVER.

Exploitation of quicksilver deposits in Lake county began in the early sixties and it has been one of the largest producers of this metal in the State. The history, geological occurrence, development and metallurgical treatment of the ores at the different mines in this county are given in detail in Bulletin No. 78. The notes here given

touch only on operations and new developments during the current year.

Abbott Mine. The property has been acquired by the Alpha Quicksilver Company, a Nevada corporation, offices 303-304 Clay Peters Building, Reno, Nevada. Mine address Wilbur Springs, Colusa County, California. It is in process of financing and reopening.

Anderson Prospects. See Big Chief.

Baker Mine. Idle.

Big Chief. This property, belonging to the Anderson family of Anderson Springs, has been taken under lease by R. B. Crowell, Middletown. A total area of 100 acres is covered by the lease. During 1918 ore from this mine was retorted at the Big Injun, but most of the Big Injun equipment has now been removed to the Big Chief property. The mine is situated on the rugged hills above Anderson Springs at an elevation of 2300 feet. There are some fir and oak. Country rock is sandstone and serpentine. Cinnabar occurs in veins associated with the serpentine. A heavy black gouge is usually present along the walls. The strike of the principal vein is southwest and the dip 45°. It has a maximum width of 30 feet. A shaft reaches a depth of 40 feet on the vein and there are two adits. The upper adit was in 73 feet at the time of visit and will, when extended, cut the vein at a depth of 375 feet. Hand drilling is employed. The ground is wet and difficult to hold. Considerable ore was exposed in the various tunnels but the workings were badly covered. It was idle at the time of visit pending the arrival of necessary equipment for ventilating as the hot and gaseous atmosphere hindered efficient work. Two 18″ D-retorts composed the reduction equipment.

Big Injun Mine. This property closed down in 1918 on account of a bad cave-in and shortage of labor. A little work was done in 1919 on the dump with a concentrating table and a small amount of mercury produced. Most of the reduction plant has now been removed to the Big Chief.

Bullion Mine. The equipment at this mine was destroyed by fire in 1917 and it has been idle since.

Chicago Mine. Idle. It is stated that the concrete furnace referred to in Bulletin No. 78 was never tried out.

Great Western Mine. Idle. Worked out.

Helen Mine. The Helen mine has been active throughout the year, operations being carried on at a reduced scale however. Mining is prosecuted during the winter months and the furnace run in the summer only. Twelve men were employed at the time of visit. The owner reports labor scarce. A minimum wage of $4 is paid.

Lucitta Mine. Idle.

Mirabel Mine. Idle.

Red Elephant Prospect. This property is now known as the **Red Elephant Quicksilver Mine.** It is owned by the Red Elephant Quicksilver Mining Company, Joseph Smith, president, C. F. Tremper, secretary; home office, San Francisco; W. G. Tremper, superintendent at mine; postoffice, Lower Lake, California. The property includes the Red Comet, Red Elephant, Royal Annex and Blue Wing Claims (all unpatented), also the Rex Quicksilver Mining claim and a tunnel site and mill site locations. The country rock is mainly serpentine and there is little vegetation except brush. Elevation 2400 feet (bar.). Sufficient water for domestic use is obtained from springs. A road has been built to the property and development work was started in the latter part of 1918. The working shaft is now down 125 feet. Levels have been started at 55 foot and 108 foot depths. A cross cut on the upper level is in 103′ and on the 108′ level a drift has been run 137 feet. Ore was encountered in the upper level, 38 feet from the shaft and continues to the face. It carries cinnabar and is reported to average about 1%. Hand drilling is used.

The mine is equipped with a 6-horse-power gasoline engine and hoist, cars and track, camp buildings and substantial head frame and shaft house. Three men were employed up to June 15, when operations were temporarily suspended on account of impossibility of getting in lumber and supplies. One man was keeping the workings unwatered and in shape for starting work again at the time of visit.

Red Rock and Silver Rock Claims. Idle.

Sulphur Bank Mine. This property was closed down early in 1919. It was locally stated that the revolving furnace, mentioned in Bulletin No. 78, as being in process of erection, did not work satisfactorily with the Sulphur Bank ore.

Thorne Mine. Idle.

Utopia Mine. Idle.

Wall Street Mine. The owner has continued to work alone at this mine, producing an occasional flask of quicksilver.

White Elephant. Idle.

G. L. Hildebrand Property. Eugene Wilkinson of Middletown is reported to be doing development work on a quicksilver prospect on the Hildebrand ranch just south of the Lucitta Mine on the slope of Mount Konocti (or Uncle Sam).

Hutchinson Ranch. Good showings of cinnabar ore reported to occur on patented land on the Hutchinson Ranch southeast of Lower Lake.

MADERA COUNTY.

The western half of Madera County lies in the San Joaquin Valley, while the eastern border line runs along the summit of the divide of the Sierra Nevada Mountains, and includes a number of peaks exceeding 12,000 feet in altitude. A general description of the geology of the county may be found on page 105 of the Fourteenth Report of the State Mineralogist.

ASBESTOS.

Amphibole asbestos occurs at the **Savannah Mine** near Grub Gulch, and at the **Baker Mine** near Coarse Gold. It is said that the former occurrence has been traced over a distance of about three miles in length. No development work has been done on either deposit.

BUILDING MATERIAL.

For many years **Mr. J. A. Dyer,** Madera, operated a brick yard at the southern edge of town in which a considerable number of men were employed. The clay from which the bricks were manufactured occurs in a deposit covering sixteen acres. About six acres have been worked out. No brick have been manufactured since 1918, and the property is now for sale.

COPPER.

The foot-hill copper belt extends in a southeasterly direction through Madera County, and on into Fresno County. During the copper excitement in the 60's, a number of properties were developed in this region, many of which have been described in the Fourteenth as well as in earlier reports of the Bureau. During the past year there has been no activity in this regard, although in 1919 the **Daulton Mine,** Mr. L. M. Bradford, Madera, owner, shipped two cars of 7% copper ore to the Tacoma smelter. Considerable amounts of a similar grade of ore are said to be blocked out in the mine, but the operating and transportation costs are so high that the property has been forced to close down.

The **Apex Copper Mine,** Mr. Geo. Bever, Berenda post office, is located about three miles northeast of the Daulton. After a little prospecting work had been done, a small flotation plant was built on this property in 1919, but unfortunately development work subsequently carried on failed to produce ore, either in sufficient quality or quantity to make the venture profitable. It is now idle.

GOLD.

The **Texas Flat Gold Mine,** situated in section 6, T. 8 S., R. 21 E., 1 mile northwest of Forest Grove, is the only gold mine in Madera County which has operated during the past year. The property, which has been under bond to the Texas Flat Mining and Development Company, reverted to the Kroromick Mining Company in April, 1920, H. A. Krohn of Coarse Gold, general manager. During the past summer the work of sinking a shaft on the vein has progressed satisfactorily. Six men are employed.

Full details relative to the many other gold mines and prospects in Madera County will be found in the Fourteenth Report, page 113. Many of these properties show considerable promise; some of them have been large producers in the past, but under present adverse conditions gold mining here as well as in all other parts of the state has suffered severely.

IRON.

Immense iron deposits are known to exist in the Sierra Nevada region of northeastern Madera County. No development has been undertaken on any of these deposits during the past several years, although their potential value is very great. Details relative to this subject, as well as a special article by F. B. Weeks on the Minaret Iron Deposits, will be found on pages 128 and 129 of the Fourteenth Report.

OTHER MINERALS.

The above-mentioned report also describes in detail properties from which have been produced lead, molybdenite, nickel, silver, soapstone, granite, sand and gravel, tungsten, volcanic ash and zinc. Practically all these branches of the mineral industry were dormant during the year 1920. Even the immense granite quarries near Raymond have only been operating part of the time. The Primmer Artificial Stone Company, mentioned on page 141 of the Fourteenth Report, is now owned by Adell and Cartwright of Madera. This firm manufactures cement pipe only, and uses sand and gravel obtained from the Fresno River north of Madera. The Santa Fe Gravel Company, which formerly operated a gravel pit on the San Joaquin River, one mile north of Herndon, has dismantled the plant and ceased operations.

MARIN COUNTY.

With the exception of San Francisco, Marin is the smallest county in California, having a land area of only 529 square miles. Its topography is quite rugged and picturesque. This county is not especially prolific in minerals, although among its resources are clay, gems, manganese, mineral water, soapstone and miscellaneous stone.

The only commercial production reported for many years has been that of brick, crushed rock and mineral water. During the past year the output of these substances was valued at about a quarter of a million dollars.

No field work was carried on in Marin County during 1920, but a detailed description of its mineral resources and individual deposits is contained in the Fourteenth Report of the State Mineralogist.

MARIPOSA COUNTY.

By W. O. Castello.

Mariposa County lies in the central eastern part of the state and extends from the eastern edge of the San Joaquin Valley into the high mountain region of the Sierra Nevada. It is noted for having within its boundaries the world-famed Yosemite Valley, and the Mariposa Grove of Big Trees.

The county has an area of 1463 square miles, and an estimated population of 4000. Tuolumne County lies to the north, Madera to the south and east, and Merced to the west.

MINERAL PRODUCTION.

Although regarded as one of the strictly mining counties of the state, it stood in 1919 only thirtieth in the list of counties, in regard to value of its mineral output.

In 1919 the total value of the commercial minerals produced in the county was $410,535, as compared with $352,504 in 1918.

Commercial production for 1919 was as follows:

Copper, 24,897 pounds	$4,627 00
Gold	400,000 00
Silver	5,500 00
Stone, miscellaneous	400 00
Other minerals	8 00
	$410,535 00

Besides the minerals mentioned above, there are known to be deposits of asbestos, barytes, gems, marble, slate, soapstone, and platinum.

HISTORY.

The southern extremity of the famous Mother Lode lies within the county, and for many years Mariposa shared with its neighbors to the north, the activities and prosperity of the early mining days of California. Along its streams placer mining was extensively carried on, and the richness of some of these deposits was not eclipsed anywhere in the state.

While small fortunes were being made in placer workings, attention was being turned to the development of quartz claims along the Mother Lode, and many properties were opened which have since made enviable records as producers.

About fifteen miles of the lode was at that time, and is still, included in the Mariposa Grant, a tract of some 44,000 acres originally granted to Col. John C. Fremont. Many mines were opened on the Grant which have since produced millions of dollars.

In the early sixties several large copper mines were developed along the Foothill Copper Belt, which resulted in the first smelting operations in the state.

During the early days, the present town of Mariposa was a city of several thousand inhabitants, and Mount Bullion (formerly called Princeton), Bear Valley, Mormon Bar, Hornitos, Coulterville, and other places were thriving centers. There were towns of several hundred people at places, where, at the present time, only slight evidence of

former occupation can be seen. In Hunter Valley the old copper mines, Barretta and La Victoria, together with gold placers and a few quartz mines, supported a village of 300 or 400 people.

At Whitlock, Hites Cove, and other points a few old buildings, now fallen to ruin, here and there a brick or stone foundation, and a few scattered pieces of old machinery, are mute evidence of former prosperity. Gold mining in the county has suffered a relapse since the "boom days."

There were in October, 1919, only four mines in the county which could truly be said to be operating on a producing basis—the Ruth Pierce, Virginia, Mountain King and the Original Mining and Milling Company's property at Clearing House. This is a lamentable fact when one considers that there are in the neighborhood of 200 mines, more or less developed, in Mariposa County, not counting mere prospects.

And many of the 200 mines, now idle, have proven themselves to be properties of merit, have large production to their credit, and are worthy of at least an investigation by capital.

There are, it is true, several properties, in various parts of the county, now in course of development. In almost every case, this work is being done by people with limited means.

There are several reasons why capital has been discouraged from investing in Mariposa County during recent years. The principal one is, no doubt, the great area of mineral land owned by large companies. As previously mentioned the Mariposa Grant covers 44,000 acres, extending from the Merced River at Bagby, on the north, to a point four miles south of Mariposa on the south. This property is now owned by the Mariposa Commercial and Mining Company, E. H. Benjamin, 522 Nevada Bank Building, San Francisco, president; H. G. Stevenson, secretary. It is understood the principal owner was the late Hennin Jennings of New York. Years ago many mines on the Grant were extensively operated, but of recent years they have been idle, except for the operations of a few leasers.

The ore was, for the most part, low grade, wood for fuel became scarce, the expense of operating increased, so that development work gradually ceased, and when the best quality ore was worked out, the mines closed. It is a question whether or not these mines could be made to pay under present day conditions.

Messrs. A. S. Bigelow and G. M. Hyans of Boston, formerly of the Merced Gold Mining Company, now dissolved, own a great area of mineral land near Coulterville. There are, in all, 25 quartz claims, 7 mill sites, two 160-acre homesteads, and 160 acres of patented timber land nine miles above Coulterville, total about 1000 acres.

Some 20 years ago operations were on a very large scale. There were four principal producing mines, the Mary Harrison, Louise, Malvina, and Potosi. The ore was treated in a 40-stamp mill at the Potosi, and was hauled from the other mines by a steam locomotive and train of large ore cars over $3\frac{1}{2}$ miles of narrow gauge track. A large concrete bridge was built to carry the track across Maxwell Creek at Coulterville. Steam power was used, with wood for fuel. The equipment, still in place, consists of several 60 h.p. steam boilers, steam engines, compressors, Corliss hoists with flat cables, and completely equipped machine shop, with the 40-stamp mill.

Here also wood for fuel became scarce, and with such equipment, operating costs were so high that the fairly low grade ore could not be worked at a profit.

The owners will not sell any single part of the equipment, but the entire property is for sale.

The Bondurant property, located about 10 miles northeast of Coulterville, also consists of almost 1000 acres of mineral land.

Outside of the companies mentioned there are many properties which have been extensively developed, but which have been idle for many years. The reason for this in a great many cases appears to be lack of funds for further development work, after low grade ore had been encountered.

In several cases properties have been leased, and thousands of dollars expended on surface equipment before opening up a satisfactory ore body. Funds which should have been spent in development were invested in equipment which could not be utilized. In other cases, mines have been brought close to the point of production, but operations have had to cease for lack of funds.

In many cases, owners have apparently given up hope of ever interesting capital in their properties, and buildings and machinery are going to ruin. In other cases prospectors and people without means are tenaciously holding on to mines which they have partly developed in the hope of some day interesting worthy people.

If, in some way, sufficient capital could be interested, and induced to place some of the best old properties again on a producing basis, Mariposa County would, no doubt, assume a more favorable place in the list of real mining counties in the state, along with its neighbors to the north, Tuolumne, Calaveras, and Amador counties.

TOPOGRAPHY.

The topography of the county is given in detail on the following topography sheets of the U. S. Geological Survey: Sonora, Yosemite, Yosemite National Park, and Yosemite Valley Special. These sheets may be obtained, at small cost, by writing to the U. S. Geological Survey, Washington, D. C., and they are for sale at many stationery and book stores.

The topography varies, from the valley floor in the extreme southwest corner of the county, through the rolling foothills of the central portion, to the high Sierras on the eastern border, where the elevation is over 10,000 feet. In this eastern portion lies the world-famed Yosemite Valley, unmatched for scenic beauty anywhere in the world. The crystal clear Merced River, fed by the melting glaciers on the higher peaks, flows through this beautiful valley, forming unmatched water falls, rapids, and lakes. Sheer granite walls rise 3000 feet on either side.

The greater part of the county is exceedingly rugged, and cut into many deep canyons and high ridges by winding streams.

There are many small and beautiful valleys, even in the higher country, where some farming and fruit and stock raising is carried on, but, on the whole, there is very little good agricultural land in the county. In the lower foothill area, in Hunter Valley, and the southwesterly portion of the county is grazing land suitable for stock raising, and some farming land.

Besides the Yosemite Valley, the county is also famous for the Mariposa Grove of Big Trees, which contains some of the largest redwoods in the world.

The Bower Cave, situated 12 miles east of Coulterville, on the road to the Yosemite Valley, is also a natural wonder. It has been carved by percolating waters, from a limestone belt, which extends through that district, and is about 1000 feet in circumference. There is a beautiful fresh water lake in the bottom, 60 feet deep, 85 feet wide, and 130 feet long. The colorings on the limestone walls and in the lake at different times of day are magnificent. Many grotesque and life-like figures have been made by Nature in the walls. A resort is maintained at the cave.

GEOLOGY.

The geology of a large portion of the county, including the Mother Lode region from the vicinity of Mount Bullion to a considerable distance beyond the northern boundary of the county, is given in detail in the Sonora Folio number 41, of the U. S. Geological Survey. This folio also gives the topography, as well as a general description of the geology of the gold belt.

The eastern part of the county, the region of the Yosemite Valley and the High Sierra, is made up entirely of granite. There has been no mining in this region.

The contact between this granite mass, and the broad belt of Calaveras slates to the west, is a very irregular line, extending in a general northwest and southeast direction.

This belt of Calaveras slates is over ten miles wide, containing lenses of limestone and quartzite, and the scattered gold quartz vein of the east belt.

In general the geology of the western part of the county consists of parallel belts of slates, amphibolite schist, porphyrite, and serpentine, trending in a northwesterly-southeasterly direction, and including igneous intrusions.

The Mother Lode extends from Penon Blanco, near the northern boundary of the county, through the western edge of Coulterville, crosses the Merced River a little to the north and west of Bagby, continues a little west of Bear Valley, Mount Bullion, and Mariposa, and comes to an end at the edge of Granite intrusion, a few miles southwest of Mariposa. A so-called West Belt lies about a mile to the west, and embraces the Potosi and Malvinia mines, at Coulterville, and a few other mines farther south. There are many scattered and isolated veins in both the east and the west.

The Mother Lode in Mariposa County is characterized by the great width of vein and massive outcrop. In the vicinity of Coulterville the vein is 15 feet to 20 feet or more wide, and the outcrop can be distinctly seen for miles across the county, along the crest of a series of outstanding hills. It reaches a climax at Penon Blanco, where the outcrop and workings at that mine form a landmark for miles around.

At Coulterville, Maxwell Creek cuts through the outcrop, leaving prominent massive quartz bluffs on both sides.

Further south on the Grant property the lode continues its exceptional width but the outcrop is not so prominent.

The quartz veins occur, for the most part, on the contact between the Mariposa slates and the amphibolite schist, or on the contact between either the slates or the schist and the serpentine; but many veins lie entirely within these formations.

DRAINAGE.

The Merced River, with its tributaries, forms the principal drainage system of the county. The main river after leaving Yosemite Valley flows southwesterly through the central portion of the county, turning northwesterly a few miles east of Bagby, and at Pleasant Valley turning and flowing almost due south, in the northwestern portion of the county.

The South Fork of the Merced drains the steep and rugged southeasterly portion of the county, while the North Fork drains the northwesterly portion.

The Mariposa River with its tributaries, together with the North Fork of the Chowchilla, drain the southerly portion of the county.

TRANSPORTATION.

The only railroad in the county is the Yosemite Valley Railroad, which extends from Merced to El Portal, at the entrance to Yosemite Valley. It follows closely the course of the Merced River, and the ride is a scenic one, the road being primarily built to accommodate tourist travel to the Yosemite Valley. However, it also provides many shipping points and post offices for the central portion of the county. During the summer season two trains per day are operated, but for the rest of the year only one train per day is run. A logging train is operated by the Merced Lumber Company between its large sawmill at Merced Falls and the logging camp at El Portal.

Automobile stage lines operate from Merced to Yosemite, by way of Mariposa, Miami and Wawona, during the summer season, and from Merced to Mariposa during most of the year. Other stage and mail routes are operated throughout the county, between Mariposa and Coulterville, by way of Mount Bullion, Bear Valley, and Bagby; from Coulterville to Pleasant Valley; from Coulterville to Kinsley and Yosemite by way of the Bower Cave; from Mariposa to Jerseydale; and other shorter lines.

There are no concrete highways in the county, and the roads, at least in the upper portion of the county are rough and steep. The automobile roads into Yosemite Valley have been a disgrace to the state, but this is soon to be remedied by the construction of a State Highway from Merced into the valley. This road will follow the existing highway from Merced to Mariposa. From Mariposa a new road will be built, extending northerly, through the mountains to Briceburg on the Merced River, thence following the south bank of the river into Yosemite.

A portion of this road has already been surveyed, from El Portal to a point west of Clearing House. This portion was surveyed first, so as not to interfere later with a new flume line soon to be constructed for a power house by the Original Mining and Milling Company, at Clearing House.

The roads in the lower portion of the county are, for the most part, very good, excepting in the winter time, when they are heavy and pretty well cut up.

SUPPLY POINTS.

Mariposa and Coulterville are the two largest towns in the county, and the two principal points from which provisions and supplies may be obtained. There are also stores located at Hornitos, Mount Bullion, Mormon Bar, Bagby, Boot Jack, El Portal, Yosemite Valley and Fish Camp. Accommodation and meals may be obtained at Mariposa, Coulterville, Bagby, Mountain King, Clearing House, Miami, Wawona, Fish Camp, Bower Cave, Jerseydale, Maschio's Ranch in Hunter Valley and at the several resorts in Yosemite Valley.

POWER.

The Mountain King and Original Mines have modern hydro-electric power plants of their own on the Merced River. The power house of the Mariposa Grant, at Bagby, has for many years supplied electricity for power and lighting purposes to quite a large territory south of the river, including the towns of Mount Bullion and Mariposa. The plant consists of a flume 400 feet long and 16 feet wide by 6 feet deep, which carries water under a 34-foot head to three Pelton wheels, which are 27, 30 and 40 inches in diameter, respectively. Two Westinghouse dynamos are capable of developing 600 h.p.

The power line of the Pacific Gas and Electric Company comes from Tuolumne County to the Penon Blanco mine, and thence to Coulterville and the adjacent territory. The San Joaquin Light and Power Corporation have a power plant at Merced Falls in Merced County, and one of their lines extends to Hornitos, the Mount Gains mine and on to Coulterville.

MINING DISTRICTS.

The mining districts, as here considered, apply to the principal mining sections of the county, as they exist today, and while, in most cases, it is believed they correspond to the mining districts as they may have been organized or established in the early days, it is not intended that they be here regarded in that sense.

BAGBY DISTRICT.

This district includes the several mines located on both sides of the Merced River for several miles northwest of Bagby, as well as those in Flyaway Gulch, three to four miles north of Bagby.

Bagby is a station on the Yosemite Valley Railroad, on the bank of the Merced River, about midway between El Portal and Merced Falls. It lies on the main highway between Mariposa and Coulterville. On the older maps it is called Benton Mills. The hydro-electric power plant of the Mariposa Commercial and Mining Company (Mariposa Grant) was built there in 1901; and a five-stamp mill owned by the same company is still in place, on the south bank of the river. The town consists of a hotel, store, post office, and railroad station.

Geology.

A belt of serpentine spreads out to the northward from an apex at Bagby. This belt gains a width of about two miles and then narrows

to a point again, coming to an end about two miles south of Coulterville. To the west of the serpentine is a belt of Mariposa slate, about a mile in width and trending a little west of north. In contact with the slate on the west is a broad belt, several miles wide, of porphyrite and amphibolite schist. Just east of Bagby, the serpentine to the north, and the Mariposa slate to the south, are both in contact with the broad belt of Calaveras slate. Farther to the north the serpentine is in contact with a belt of porphyrite on the east. The quartz veins are located, for the most part, on the contact between the serpentine and the slate, or between the slate and porphyry.

Topography.

The topography is quite rugged, the ridges both to the northeast and southwest of the Merced River, rising to an elevation of 2000 feet above the level of that stream. There is some small timber, oak and pine, but no great abundance. Small amount of water from springs and from the mines.

Mines.

The principal mines along the river northwest of Bagby are: Crown Peak, Crown Lead, Red Bank, Anderson, Lovely Rogers, situated on the ridge east of the river; and Stud Horse Flat group, on the ridge west of the river. In the Flyaway Gulch section are located the Blue Jay and Cuneo Brothers mines, with several other claims, undeveloped.

COULTERVILLE DISTRICT.

The Coulterville district embraces quite a large area in the vicinity of the town of Coulterville, in the northwestern part of the county. It extends from Penon Blanco near the northern boundary of the county to several miles south of Coulterville, and from about three miles west of the town to six or eight miles east, to the North Fork of the Merced River.

Coulterville is situated about nine miles northwest of Bagby and twelve miles northeast of Pleasant Valley, both the latter being stations on the Yosemite Valley Railroad. It is quite a highway center, being on one of the main routes to the Yosemite Valley. Automobile mail and stage routes are maintained between Pleasant Valley, Coulterville and Kinsley.

Topography.

The surface varies from rolling hills in the vicinity of Coulterville to greater ruggedness a few miles east. The elevation rises from 1676 feet at Coulterville to over 3500 feet, to the north and east.

Maxwell Creek flows through Coulterville and joins the Merced River at Horseshoe Bend. Black Creek flows from the north of Penon Blanco and joins Maxwell Creek about two miles southwest of Coulterville. There are several other small creeks and many springs. The North Fork Merced River on the eastern edge of the district flows in a general southerly direction through a deep cañon with precipitous sides. Timber is rather scarce in the lower western part of the district but there is an abundance in the higher easterly portion.

Geology.

The eastern part of the district is made up entirely of Calaveras slate. In contact with this on the west is a belt of porphyry and amphibolite schist averaging about 2½ miles wide and trending in a northwesterly and southeasterly direction. This belt extends from ½ mile west of Coulterville to about 2 miles east, and contains some granodiorite intrusions on the eastern border. To the west of the schist is a belt of Mariposa slate about a mile wide. Between the slate and the schist are two lenses of serpentine; one extending from north of Coulterville, past Penon Blanco, and into Tuolumne County; the other beginning about two miles south of the town and extending to Bagby. To the west of the Mariposa slate lies a broad belt, five miles wide, of porphyry. The striking features of the geology in this region are the parallel nature of the formations, and the uniform width of the belts. The general trend is about N. 35° E.

The quartz veins, for the most part, lie entirely within the slate, but some of them lie on the contact between the slate and porphyry, or between the slate and serpentine.

The principal mines are the Potosi, Malvina, Louise and Mary Harrison, all owned by A. S. Bigelow and G. M. Hyans of Boston; the Virginia, Bondurant, Champion, Quail, Red Cloud, Tyro and Louisiana.

Some of these properties were worked extensively in the early 50's, but most of them have been idle for many years. The Virginia has been in constant operation for the last several years, while the Quail has been extensively developed and will probably be on a producing basis soon. The Bondurant and Champion have been operated at intervals during the past several years.

COLORADO DISTRICT.

Situated in the central and southeasterly part of township 4 S., R. 18 E., M.D.M., about eight miles north of Mariposa and four miles south of the Merced River and the Yosemite Valley Railroad, Saxon Creek and Briceburg stations on the railroad, are both reached by short trails. The wagon road from Mariposa is steep and rough.

The topography is rough and the elevation varies from 2400 feet to 3600 feet. Timber is not abundant, but generally there is enough for mine timbering purposes. Water for milling operations is derived from springs, from the mines, and from Saxon Creek and Bear Creek. There is an abundant supply in the winter, but it is rather scarce in the summer.

The country rock is Calaveras slate with some porphyry. The veins occur either entirely in the slate or on the contacts between the slate and porphyry. The general strike of the vein is N. and S. or NW. and SE. and the dip is mostly to the E. They vary from 2′ to 6′ in width. The principal mines are the Colorado Champion, Feliciana, Sierra Rica, Schroeder Group, Recorder, Mocking Bird and Little Bear.

Some of the mines in this district were located in the early 50's, but quite a few have been located since 1890. There has not been much activity in recent years, some of the properties being worked only in the winter. There is also some placer mining carried on in this district during the winter months when the water is plentiful.

HORNITOS DISTRICT.

Located in the western central part of the county, north and east of Hornitos, about 10 miles east of Merced Falls on the Yosemite Valley Railroad. The surface is low rolling hills, elevation from 1000 feet to 2500 feet. Hornitos Creek, Burns Creek, and El Dorado Creek flow southwesterly and drain the district. There is very little timber.

Geology.

A belt of metamorphic Mariposa slate, from three to five miles wide, lies east of Hornitos. The contact between this slate and the belt of porphyry to the west extends northwesterly and southeasterly through the western part of the town of Hornitos. To the east of the slate is another broad belt, three miles wide, of porphyry. There are several intrusions of diabase and granodiorite in the slate. The veins occur in the slate, and in the contact between the slate and the diabase granodiorite a porphyry. The most notable mines are the Mount Gaines, Ruth Pierce, No. 1, No. 5, No. 9, and Silver Lead. The Ruth Pierce is the only one in the district that has been operating on a producing basis, in recent years. The Mount Gaines was operated on a large scale years ago. It was closed down in 1910. There is a 20-stamp mill on this property. The Silver Lead was being developed (October, 1919), and the No. 9 was ready to start if litigation could be settled.

HITE COVE DISTRICT.

This is a comparatively small district, situated on the South Fork Merced River, in the southeastern part of township 3 S., R. 19 E. It is 4 miles by trail from South Fork, a siding on the Yosemite Valley Railroad, at the junction of the South Fork with the main Merced River. A shorter trail leads from Clearing House, over the ridge south of the river. A wagon road extends from Jerseydale, northward, down into the North Fork canyon, but this is very steep, and practically impassable by automobile. The topography is very rugged, the South Fork, winding through a deep canyon with steep sides, and the elevation rising from 1600 feet at the river to over 5000 feet. There is some timber but not an abundance.

The country rock is Calaveras slate, but there are some granitic intrusions. The most important property is the old Hite mine on the north bank of the river. It was located in 1863 and was a large producer for many years. It has been idle since 1882. Other mines are: Emma, Bunker Hill (Old Squirrel). There has been no production in this district for a great many years.

HUNTER VALLEY DISTRICT.

Hunter Valley lies in the northwestern part of Mariposa County, twelve to fifteen miles north of Hornitos. It is a narrow valley, four or five miles long, extending in a northwesterly and southeasterly direction, and separated from the Merced River on the northeast by a ridge which rises to an elevation of 3000 feet. The mountains to the south and west are lower. The elevation of the valley itself is from 1500 to 1800 feet, and the surface is rolling, with considerable good farming and grazing land. The residents are mostly Italians, who follow cattle raising and farming for a living. Accommodations may be had at

Maschio's Ranch in the central part of the valley. A good road extends from Hornitos, which is the nearest town, post office, and supply point. A good road also leads into the valley from Bear Valley, which is on the main highway from Mariposa to Bagby and Coulterville. Bagby is reached by trail. Jasper station, on the Yosemite Valley Railroad, is two miles from the north end of the valley, but there is no road.

Cotton Creek and Temperance Creek with their branches form the drainage system for the district. Both flow westerly and join the Merced River. There is considerable small oak and pine timber. The main power line of the San Joaquin Light and Power Company passes through Jasper station on the Merced River.

Geology.

The country rock is porphyrite (altered lavas, having the composition of andesite) and which extends for about six miles through the valley. There are also small intrusions of diorite and granodiorite. The district has produced both copper and gold, but no mines have been in operation for several years.

There are about 1500 acres of patented land in the valley, and some fifteen or more full sized mineral locations.

The old copper mines, La Victoria and Barretta, now Beaudry, were operated in the early 60's and some of the ore was smelted there in a crude smelter. The district was extensively placered for gold, many rich pockets being found, and several gold mines were developed, among which may be mentioned the Oaks and Reese, Horse Shoe, School House, Iron Duke, Castagnetto, Beaudry (Barretta) and Lafayette. A small town existed in the early days, of which no trace now remains.

The high grade copper ore, near the surface, was worked out, and no one has undertaken to work through the lean zone to see what lies at depth. Apparently this too large an undertaking and risk for small capital, and the district has been so long neglected that it is a hard matter to interest large capital.

The gold veins occur along what is known as the "Blue Lead," a well defined lode, which lies approximately parallel to the Mother Lode and dips 60° to 80° northeast. Many smaller veins, or stringers, run into this main lead at right angles, and it is generally on or near these cross veins that the values occur. The Oaks and Reese, the most important gold mines in the district, was a large producer years ago. Several other properties have been developed to considerable extent and some have made considerable production. In the eastern part of the valley there are many irregular cross veins, running in all directions. Some of these have been prospected to a shallow depth by old shafts and tunnels and open cuts.

KINSLEY DISTRICT.

The Kinsley district lies in the north central part of the county, about six miles north of the Merced River and eighteen miles by wagon road east of Coulterville. An automobile stage and mail route runs from Coulterville, which is the nearest town and supply point. The district is drained by Bull Creek and the North Fork of the Merced River. The topography is very steep and rugged, the elevation varying from 1800 feet to 4000 feet. Bull Creek flows westerly past Kinsley

and joins the North Fork of the Merced in a deep canyon. On the steep banks of these streams are situated the Carrie Todd, Bandarita, Marble Springs (Compromise), Contention, Cranberry, Garibaldi and other old and abandoned properties. The Carrie Todd and Marble Springs were the only ones being developed in the latter part of 1919.

The district lies entirely within the belt of Calaveras slate. There are small intrusions of granodiorite. Most of the quartz veins lie entirely within the slate, but some are on the contact between the slate and the diorite.

The older properties were located in the early days, and most of them have been idle and deserted for thirty or forty years. Some of them have made considerable production. In the early part of 1920 a 10-stamp mill was being erected at the Carrie Todd, and development work was going on at the Marble Springs.

MARIPOSA DISTRICT.

In this district are included the several scattered and more or less isolated mines, situated east and south of the town of Mariposa, namely, the Mariposa and Stockton Creek Mines, owned by the Mariposa Commercial and Mining Company, and the Silver, Malone or Bear Creek, Vanderbilt or Mount Buckingham Group, and the Prothero Brothers mine, south of Bootjack.

The topography of the district is quite rugged, but most of the mines are reached by fairly good roads from Mariposa, via Mounar Bar, Bootjack, and the Jerseydale road, or by road northeast from Mariposa.

The nearest railway stations are Raymond, Madera County, and Bagby on the Yosemite Valley Railroad.

The elevation ranges from 2500 to 4500 feet. Stockton Creek, Snow Creek, and the North Fork Chowchilla River drain the district. Water is very scarce in the summer time in the higher portions. Timber is plentiful but not abundant.

Geology.

The greater part of the district lies in the granite area. The Calaveras slate lies in irregular contact with the granite on the north, and on the west a long strip of Mariposa slate extends into the granite from Mariposa southerly into Madera County. The eastern contact between this long, narrow belt of Mariposa slate and the granite lies about three miles east of the town of Mariposa, extends southerly close to Bootjack, and continues a little east of south.

The veins lie in the granite, in the slate, or on the contact between the two.

Some of the mines were worked in the early days. In the early part of 1920 the Silver mine and the Prothero Brothers mine were being developed. None of the others were in operation. The Mount Buckingham group is one of the largest low grade properties in the county. It has not been worked since 1914.

WHITLOCK DISTRICT.

This district is situated in the central part of the county, in sections 29, 30, 31, 32 and 33 of T. 4 S., R. 18 E., from 6 to 9 miles north of Mariposa. Briceburg, on the Yosemite Valley Railroad and the Merced

River, is situated to the north, and reached by 2½ miles of wagon road and 5 miles of trail. A good road, steep in places, extends from Mariposa, which is the nearest town, post office and supply point.

The topography is quite steep and rugged, the elevation varying from 2500 feet to over 4000 feet. Water supply is derived from Whitlock Creek, and from many springs. Small timber is quite plentiful.

The greater part of the district lies within a belt of porphyry, the Calaveras slate being in contact with the porphyry, just to the north.

Nearly all the veins occur between porphyry walls but occasionally one of the walls is slate.

Some of the claims were located in the early 50's, and a few years later several properties were in operation, which supported a small town at Whitlock. The town has now disappeared, however, and very few of the properties have been in operation on a producing basis of recent years. Many of the claims have been relocated several times. Among the most important gold mines are: Sunshine Group, Spread Eagle, Spencer, Our Chance, Mohawk, Miners Hope (formerly Farmers Hope), London, Herman, Geary, Garden, Diltz, Bull Dog, and Ah War (placer).

JERSEYDALE–SWEETWATER DISTRICT.

This district is located in the central and southeasterly part of township 4 S., R. 19 E., principally in sections 20 to 27, inclusive. It is about 18 miles by good wagon road northeast of Mariposa, the nearest town and supply point. An automobile mail and passenger stage runs between Mariposa and Jerseydale during most of the year. There is a postoffice and boarding house at Jerseydale. A wagon road, which is very steep and practically impassable by automobiles, leads northward into Hite Cove, on the South Fork Merced River, and a trail leads thence to the Yosemite Valley Railroad on the bank of the Merced River.

The topography is quite rugged, the elevation varying from 3500 to 4500 feet.

The district lies on quite a prominent drainage divide. Sweetwater Creek and Feliciana Creek flow northward to the main Merced River, Snyder Creek flows northeasterly to the South Fork Merced. Skelton Creek flows southerly and then northeasterly to the South Fork. Snow Creek flows southerly and several branches of Bear Creek flow westerly.

Timber is quite plentiful in most parts of the district.

Geology.

The contact between the granite to the east and south, and the Calaveras slate to the west and north, runs irregularly through the districts. There are also small areas of porphyry.

The quartz veins occur, for the most part, in the granite. Some are on the contact between the granite and the slate, or between the granite and the porphyry.

The principal mines are: Comet, Monte Christo group, Blue Bell, Louisa, Sweetwater, and Early. The old Sweetwater mine was reopened and placed on a producing basis in the latter part of 1919. The Early mine was worked in 1918, but has been idle since. None of the other properties have been worked for years. The Comet is well equipped

with 10-stamp mill, saw mill, assay office, etc. Some of the properties were located as early as 1858 or 1860, and have had quite varied histories since then.

MOUNT BULLION–BEAR VALLEY DISTRICT.

This district includes the properties of the Mariposa Grant (Mariposa Commercial and Mining Company) described on page 124.

Mount Bullion, formerly called Princeton, is 5 miles, by good road, northwest of Mariposa, and twelve miles southeast of Bagby on the Yosemite Valley Railroad. A good road also leads westerly to Hornitos. The town consists of store, school, post office, the Princeton mine, and thirty to forty dwellings.

Bear Valley, midway between Mount Bullion and Bagby, is practically deserted now. It was quite a thriving town in early days. On the road between Mount Bullion and Bear Valley may be seen the ruins of the first mint in California. Fifty-dollar slugs were coined there.

Topography.

From Mariposa to Mount Bullion the road extends through rolling country at an elevation of about 2200 feet. North of Mount Bullion a valley, nearly two miles wide and four miles long, extends northwesterly and southeasterly, at an elevation of about 1800 feet. A ridge, terminating in Bullion Mountain, elevation 4215 feet, rises to the northeast, Bear Creek flows through the valley, from north of the town of Bear Valley.

The country south from Bagby is very rugged, the road winding down a precipitous mountain side to the Merced River.

Geology.

A belt of Mariposa slate, two miles wide at the south, but narrowing to one mile in width at Bear Valley and Bagby, extends northwesterly through the center of the district. In contact with the slate on both the east and the west are broad belts of porphyry.

Narrow strips of serpentine lie between the slate and porphyry on the east. Near Bagby the Calaveras slate comes in on the east, cutting out the porphyry, and a very narrow belt of serpentine separates it from the Mariposa slate.

The larger quartz veins lie in the slate or on the contact between the slate and the porphyry. The more important mines are: Princeton, Pine Tree, Mount Ophir. Queen Specimen, Josephine, Texas, Guadaloupe, Mexican, Alice, Elizabeth, and Long Mary. The veins are generally of great width, but low grade. Of recent years several of the properties have been worked to some extent by lessees.

GREEN MOUNTAIN DISTRICT.

This district embraces the copper mines in the southern part of the county along what is known as the Foothill Copper Belt. There are no gold mines in the district, although the copper ores often carry large gold values.

The mines were located and operated in the early sixties, and thousands of tons of ore were mined and shipped, the industry supporting a considerable population. Some of the earliest attempts at copper

smelting in the state were carried on. The most important properties were: the Green Mountain Group, Lone Tree, Pocahontas, Great Northern, Cavan, and White Rock. With the exception of the Green Mountain group the mines have been idle for many years.

Good roads extend through the rolling foothill district, from Mariposa to Raymond, in Madera County, via Bridgeport, Leion, Ben Hur, Green Mountain, and Donavan.

The country is scarcely settled, there being little good farming land. Over most of the district the surface is barren, with only a few oaks here and there.

The drainage is all southwesterly, the principal streams being Mariposa and Chowchilla Rivers, Deadman's Creek, Dutchman's Creek, and Owen's Creek.

Raymond, Madera County, is the nearest railroad station.

Geology.

The district lies within the large granite mass, which comes in to the west, just south of Mariposa. The granite is bordered on both the east and west by the Mariposa slate.

The ores near the surface are copper, oxides, and carbonates, but at greater depth, sulphides are encountered.

Mineral Production of Mariposa County, 1880–1919.

Year	Barite	Copper		Gold	Silver	Stone	Lead	Other minerals	Total
1880				$150,017	$1,300				$151,317
1881				200,000	1,200				201,200
1882				250,000	4,000				254,000
1883				220,000	3,000				223,000
1884				180,000					180,000
1885				149,177	100				149,277
1886				197,600					197,600
1887				187,165	96				187,261
1888				175,000	250				175,250
1889				145,819	210				146,029
1890				124,265	22				124,287
1891				84,414					84,414
1892				81,011	67				81,078
1893				164,116	307				164,423
1894				153,708	39				153,747
1895				216,622	7				216,629
1896				335,637	180				335,817
1897				451,427	660				452,087
1898				336,418	993				337,411
1899				562,829	2,207			110 sq. slate, $600	565,636
1900				157,653	13,853				171,516
1901		191,622#	$30,180	504,928	4,787		77,000# $3,080		542,975
19.2		104,700	11,940	631,478	3,880				647,298
1903		61,627	6,808	542,335	3,353				552,516
1904		11,500	1,466	429,771	2,839				434,076
1905		12,541	1,956	386,380	5,231			(1) $25	393,592
1906				363,394	3,377				369,771
1907				405,498	4,500		1,142# $69		410,058
1908		29,124	2,958	439,862	4,732	$36,560			484,112
1909	800T $4,800			393,465	2,729	62,430		Unapportioned, $8,431	470,055
1910				317,580	2,364	21,501			346 245
1911		14,641	1,830	172,532	1,390				175,752
1912		284,587	46,957	160,541	6,796				214,294
1913		416,031	64,485	171,034	7,430			3,130	246,079
	2,000								

1914	$3,000	277,472	36,904	132,000	500	15,366	---	(2) 100 cu. ft., 100	187,870
1915	---	38,630	6,760	385,577	2,175	17,214	---	600	412,326
							1,857#		
1916	---	162,318	39,930	401,718	2,680	39,372	$128	4,143	487,971
1917	---	53,381	14,583	313,296	3,221	7,646	1,075#	13,399	
							$92		352,237
1918	---	30,294	7,483	337,682	5,083	400	---	(3) 1,856	352,504
1919	---	24,879	4,627	253,392	4,139	400	---	8	410,535
	2,800T	1,713,347#	$278,867	2,800T	1,713,347#	$278,867	---	$32,292	$12,042,245
	$7,800								

(1) Platinum.

(2) Marble.

(3) Chromite and lead.

ASBESTOS.

Asbestos of the amphibole variety has been found at several places in the county in the amphibolite and serpentine areas. It is impure and the quantity is not sufficient for commercial production. A specimen is on exhibition at the Mariposa Chamber of Commerce by P. W. Judkins, from the southern part of the county. There are said to be a few occurrences in serpentine areas between Bagby and Coulterville.

BARYTES.

The El Portal Mining Company, office at American National Bank Building, San Francisco, owns a deposit of barytes on the north bank of the Merced River, about 1 mile west of El Portal. There is a quarry on the hillside above the river, and a surface tram down to a storage bin beside the tracks of the Yosemite Valley Railroad. The deposit is mostly barium sulphate, but within the last few years considerable witherite (barium carbonate) has been produced.

COPPER.

In the western part of Mariposa County the foothill copper belt extends for about forty miles, from the old Barretta and La Victoria mines in Hunter Valley, to the Green Mountain group, situated seven miles north of Raymond, Madera County. Some of these deposits attracted attention in the earliest years of the industry, and resulted in the building of what is believed to have been the first smelter in California, the ruins of which may still be seen along the roadside a few miles north of the Green Mountain mines. It was built of blocks of slate, in a crude way, but some copper ore was smelted there.

In the sixties the copper mines supported a considerable population in Mariposa County, and thousands of tons of ore were mined and shipped. Of recent years there has been very little activity in the industry, and most of the old properties are deserted, the buildings fallen to ruin, equipment gone, and workings caved. The surface high grade ore has been pretty well worked out, and no one has undertaken to develop a new ore body at greater depth. It is too large a job for small operators, and probably not large enough to warrant the investment of big capital. In the latter part of 1919 ore was being shipped from the Green Mountain mines to a leaching plant at Raymond, and at the La Victoria mine, in Hunter Valley, ore from the dump was being sorted and shipped.

Barretta Mine. Located in sections 30 and 32, T. 35, R. 16 E., M. D. M., in the western part of the Hunter Valley district. This mine was worked in the sixties. There is a shaft about 200 feet deep, and a tunnel. Owned by Joseph Barretta.

Mr. C. H. Burt, Mountain View, has a bond on the property. An analysis of the ore from this mine, made by A. H. Ward, San Francisco, was as follows:

Gold, .04 oz.	$0.82	per ton
Copper	13.32%	
Iron	30.24%	
Zinc	2.00%	
Sulphur	28.51%	
Insoluble	22.70%	
	96.77%	

Green Mountain Group. This group consists of eight mineral claims and 26 acres of patented agricultural land, situated in section 3, T. 8 S., R. 18 E., M. D. M., about 8 miles by wagon road north of Raymond, Madera County. Owned by the Legioneer Gold Mining Company, O. R. Sydney and Mr. Smedburg. Two of the claims are patented, the Copper Queen and Buena Vista, while the six other claims, Copper Chief, Buster Brown, Cuban Nigger, Flotsam, Jetsam, and Amador, are unpatented.

The workings are on the top and sides of an unwooded hill. The topography is low rolling hills, and the country rock is schist. Dikes of diorite and granite cut the schist. The ore consists of oxides and carbonates. The vein is in the nature of a replacement in the schist, and has no distinct strike, as it has been followed in the form of a semicircle. The dip is about 76 feet from the horizontal. The developments consist of a 180-foot shaft, and over 4000 feet of underground workings, with many stopes.

The property has been leased several times, and it is impossible to give any accurate figures as to production. In 1914 leasers are said to have shipped 52 cars of ore, which averaged $1000 per car. Assays showed 2 oz. in silver, but no gold value.

About the middle of 1919 the United Chemicals Company of San Francisco, completed the construction of a leaching and precipitating plant at Raymond. This company is now (1919) operating, using the Green Mountain ore, which is hauled to Raymond in motor trucks.

The average ore leached contains about 6% copper. Some of the ore runs as high as 12%, so that considerable low grade ore is used, being mixed with the higher grade to make a 6% product.

Although the plant is located in Madera County, a short description of the process will be given here. The ore is first leached with water, in a wooden tank about 12 feet in diameter and 3 feet deep. The solution then goes to 14 electrolitic cells where the copper is precipitated on scrap iron. This copper is then treated with H_2SO_4 for the production of chemically pure copper sulphate ($CuSO_4$).

The products are: so-called chemically pure copper (copper oxide); copper sulphate, or bluestone, and copperas ($FeSO_4.7H_2O$). The copper oxide is a finely granular metallic copper colored product.

The property includes an electric generating plant, an acetylene cutter and welder for making the scrap iron plates for the precipitating cells, and store house, to which the tracks of the Southern Pacific Railroad (Raymond branch) have been extended.

Mr. O. R. Sydney is superintendent at the mines, and M. S. Fairbanks is in charge of the plant at Raymond. It is planned to later put in a plant at the mine, as it is believed the mine water will give better leaching results than the water at Raymond.

Pocahontas Copper Mine. (See Mariposa County, Report 1915, page 147.) Some ore was shipped by leasers in 1914 but no work has been done in the last few years.

San Jose Copper Group. (See Mariposa County, Report 1915, page 147.)

La Victoria. In sections 4, 9 and 10, T. 4 S., R 16 E., M. D. M. Owned by the Coppertown Mining and Smelting Company, Herbert

Long, East Oakland, principal owner. In Hunter Valley, 12 miles by wagon road from Hornitos.

Development consists of a 200-foot shaft, tunnel 400 feet long, several open cuts and shafts, some of which are about 75 feet deep. The ore consists of chalcopyrite, azurite, malachite and cuprite, and carries some gold. The formation is diorite and porphory.

Years ago it is said about 2000 tons of ore were shipped by way of Stockton, and 2000 tons were worked on the ground by roasting and leaching.

Mr. C. W. Wilson, 207 Hobart Building, San Francisco, had a bond on the property. When visited in October, 1919, W. C. Kroh and C. A. Felts had a working bond, and were sorting high grade carbonate ore from the dump. They had about fifty tons ready to ship, which was to be sent to a smelter at Tacoma, Washington. The freight rate from Merced Falls to Tacoma is $10 per ton, trucking charges from the mine to Merced Falls $6 per ton, and smelting charges $3.50 per ton; total $19.50, so that a high grade ore would have to be handled to return a profit.

(From "Mineral Resources West of the Rocky Mountains, 1867, by J. Ross Brown, page 151; furnace, page 163):

"The La Victoire mine, in Hunter's Valley, is a most valuable property, being second in importance to scarcely any copper mine in the state. It is located in a section of the country which has not been affected by those disturbing causes which have broken up the lodes in all the other sections. It also possesses the very great advantage of having an immense body of very good ore above the level of the surrounding country, which enables the company to extract it without the use of expensive hoisting and pumping machinery. The lode runs through a hill several hundred feet in length, and nearly 300 feet high, cropping out on the very summit of it, and traceable, unbroken, through its entire length, at an average width of nearly five feet. The proprietors, who are mostly Frenchmen, have sunk shafts on the lode, at both ends of the base of this hill to the depth of nearly 200 feet, without discovering any material difference in its appearance, the only important change being that while the lode dips to the east at an angle of 45°, at 25 feet below the surface at the base of the hill, at 100 feet lower it dips at an agle of 68°, but as it increases nearly a foot in thickness at the point where the dip changes, it is evident that the change has not been the effect of dislocation. A great deal of very rich ore has been taken out of this mine, much of it containing sufficient gold to pay for working it for that metal alone.

It may be proper in this connection to state that the copper bars made in this county, by the furnaces described above, contain a very large per cent of gold. Some of it assayed by Kellogg and Hueston of San Francisco was found to contain as high as $450 to the ton. Much of this copper contains $50 in gold to the ton; none of it less than $20.

GOLD QUARTZ.

Adelaide Quartz Mine. Located in sections 22 and 23, T. 35, R. 16 E., M. D. M., 1½ miles from Kittridge Station on the Yosemite Valley Railroad on the Merced River. A good wagon road leads from Kittridge to the mine. Owned by the estate of Mary P. MacCrellish; W. P.

Edwards of Alameda, manager. There is one patented claim, the Adelaide, 300 ft. by 3000 ft., elevation 2000 ft., no timber. The surface is fairly rough, and the country rock is slate and serpentine. There is no water supply except what comes from the mine. The vein is on the contact between serpentine footwall and slate hanging wall, and ranges from 6 feet to 10 feet in width. The ore is free milling quartz. The mine has not been worked for many years. It was bonded some years ago, the bond expiring July 1, 1914.

There is an incline shaft 150 feet deep which is partly caved and has water in the bottom. About 2500 feet of underground development work was performed, consisting in part of a tunnel which gave 300 feet of backs.

Electric power may be obtained from the power plant at Kittridge. There was formerly considerable equipment on the property, but this has been taken away.

Ah Wai Drift Mine. Consists of one unpatented placer claim in section 32, T. 4 S., R. 18 E., in the Whitlock district, about 5 miles by wagon road northwest of Mariposa, and 5 miles by trail from Saxon Creek Station on the Yosemite Valley Railroad. Elevation 1600 feet. Enough timber for mining. Formerly owned by John Hand and W. P. Weston of Mariposa, but sold a short while ago to Mr. Dickison of Mountain King. The claim was located in the 50s. The deposit is bench gravel, on a rough slate bedrock, and varies from fine, free wash to large boulders. Average about 10 feet in thickness, with pay gravel 1 to 4 feet in thickness and 40′ to 50′ wide. Water is obtained from Saxon Creek by a ditch 2 miles long, and there is a small reservoir for storage. There is a tunnel over 2000 feet long run on the bedrock. Gold is caught by means of sluice boxes, Hungarian riffles and quicksilver. The claim is worked every winter as supply of water will permit. There is a cabin, blacksmith shop, ore cars, track, drills, and tools.

Alarid Prospect. Mr. Alarid in 1916 and 1917 had a lease on property owned by the Mariposa Commercial and Mining Company (Grant), and located about 2½ miles northwest of Mariposa, presumably on the Mariposa vein. Several hundred dollars worth of ore was taken from a shaft 20 feet deep and a drift 100 feet long. Equipment consisted of windlass and bucket. The lease expired in 1918. The vein was 2½ feet wide, strike E. and W. and dip 60° S. The ore was free milling, and averaged $15 per ton.

Alice Quartz Mine. In section 16, T. 5 S., R 17 E., M. D. M., about 4 miles west of Mount Bullion and 14 miles from Merced Falls on the Yosemite Valley Railroad. Owned by the Mariposa Commercial and Mining Company, 501–502 Nevada Bank Building, San Francisco, E. H. Benjamin, president. There are two claims, which were located in the 50's. The country is fairly rough, elevation 1720 feet. Vein is in slate, both hanging and footwall, and averages 3′ in width. The strike is NW. and SE., and the dip almost vertical.

Development consists of a 200′ shaft, with a total of 360′ of drifts on 3 levels. The mine has not been worked since 1902, and there is no equipment on the property. The development work was done principally by leasers. The ore averaged about $12 per ton.

Anderson Quartz Mine. Owned by the estate of Mary P. MacCrellish; W. P. Edwards, Alameda, manager. Located in section 23, T. 3 S., R. 16 E., M.D.M., 1¼ miles by wagon road north from Kittridge on the Yosemite Valley Railroad, and 5 miles by road south of Coulterville. One patented claim, the Anderson, 300′ by 3000′. The quartz ledge is on the contact between serpentine footwall and slate hanging wall and varies from 4′ to 12′ in width. It strikes NW. and dips 65° to the NE. Development consists of 300′ incline shaft, with 3 levels, and 120′ tunnel on the vein. The mine has not been worked for the last several years. There is a blacksmith shop, bunk house, boarding house, and engine house on the property. Electric power obtained from the power house at Kittridge. Elevation 2000′. No water except from the mine.

Anderson. (Ferguson.) Located at Clearing House, on the north side of the Merced River, 7 miles west of El Portal, section 21, T. 3 S., R. 19 E., M.D.M. Owned by Mrs S. A. Hall and Anna K. Sherwood, under title of the Ferguson Consolidated Gold Mines. This is an old mine, located probably 50 years ago, and has not been worked for many years. There are extensive underground developments, consisting of five tunnels at different levels on the hillside, connected by drifts and raises, and considerable ore was stoped out. Some of the workings are now caved in. The main tunnel is about 100 feet above the level of the Merced River. The vein strikes NE. and SW. and dips to the W. There is an old compressor, which is partly buried by a slide at the mouth of the main tunnel. It is claimed this old property has considerable production to its credit.

Artru Quartz Mine. Owned by H. Artru, and consists of a fraction of a claim, 450 feet long, located in section 27, T. 4 S., R. 18 E., M. D. M., in the Colorado district. It is 3½ miles by trail from Saxon Creek Station on the Yosemite Valley Railroad, and about 6 miles by wagon road from Mariposa. The elevation is 2700 feet, very little timber, no water in the summer, and fairly rough country. The ore body is a porphyry dike averaging 20 feet in width, between slate hanging wall and footwall. It strikes NW. and SE. and dips about 70° SW. The gold occurs in pockets and is, in part, crystallized. The mine has not been worked for the past seven or eight years. Development consists of a 75-foot shaft, 450 feet of drift, four cross-cut tunnels each about 140 feet long, and several raises.

Austin Group. Four claims formerly owned by the Austin Group Mining and Milling Company. H. C. Austin, 56 Bacon Building, Oakland. Recently (October, 1919) reported sold to some New York people. Located at Whitlock in sections 29 and 32, T. 4 S., R. 18 E., about 6 miles northwest of Mariposa. Elevation 3300 feet, one claim well timbered, plenty of water in winter, but little in summer.

The quartz vein varies from six inches to four inches in width between porphyry walls.

Development consists of two incline shafts, each about 120 feet deep, a 700 foot crosscut, 150 feet of drifts, and stopes to the surface.

Equipment consists of a 10-stamp mill, plates, Pendar concentrator, compressor, blacksmith shop, bunk house boarding house and charge house. The mine has not been worked for six or seven years.

Bank of California Quartz Claim. Owned by G. E. Dunbar of 515 Southwest street, Kalamazoo, Michigan. There are two unpatented claims, located in section 27, T. 4 S., R. 18 E., M. D. M. In the Colorado district, about six miles by wagon road north from Mariposa. The vein is quartz between porphyry and slate walls, and averages $2\frac{1}{2}$ feet in width. The mine has not been worked for several years. There were two shafts which are now caved and partly filled.

Barretta Gold Quartz. (Beaudry.) Located in Hunter Valley, in section 32, T. 3 S., R. 16 E., M. D. M., about fifteen miles north of Hornitos. Now owned by Mrs. Beaudry. Property consists of two claims and 360 acres of agricultural land. Located about 1868. The elevation is about 1400 feet, surface rough. A branch of Temperance Creek runs through the property but water is not plentiful. Timber is rather scarce. The claims are on the so-called "Blue Lead" which extends in a northwesterly and southeasterly direction through the valley for five or six miles. The vein averages about four feet in thickness, strikes northwest and southeast and dips about 80° northeast. The hanging wall is chert and the footwall porphyrite.

Development consists of a number of shafts and open cuts, from a few feet to eighty feet deep, also a short tunnel. No equipment on the property.

Bear Creek Mine. (See Malone Mine.)

Benton Mill. Located on the Merced River at Bagby, and owned by the Mariposa Commercial and Mining Company. Ore from the Pine Tree, Josephine and other mines owned by the company on the Grant, was formerly hauled to this mill. It has not been in operation for years. Equipment consists of a Dodge crusher, 5 stamps, 5′ x 20′, amalgamation plate, 2 Union tables.

Blue Bell Quartz Mine. (Jumbo.) Owned by Hiram W. Bronsom of Mariposa, and located in section 9, T. 4 S., R. 20 E., about 4 miles by trail east of Jerseydale and 10 miles by trail from El Portal. Elevation 2400 feet, topography rough. The property consists of two unpatented claims located in 1906, the Blue Bell and the Blue Bell Ext. The quartz vein lies between a porphyry footwall, and both slate and granite hanging wall, and averages 5 feet in width. Its strike is north-west and south-east and its dip is 72′ northeast. The development consists of a 145′ crosscut tunnel and 80′ of drifts. No equipment, except a blacksmith shop. Mine has not been worked for several years.

Bogan and Baitaille. (B. B.) This is a "pocket mine," owned by Fred Niebold, and located by him in 1849. It consists of one fraction claim, $12\frac{1}{2}$ acres, located in the Colorado district, in section 26, T. 4 S., R. 18 E., M. D. M., about 7 miles by wagon road north from Mariposa, and 4 miles by trail from Saxon Creek Station on the Yosemite Valley Railroad. Elevation 2950 feet, topography rough. There are two veins, one contact and one gash, the former being between a porphyry footwall and a slate hanging wall, and averaging $2\frac{1}{2}$′ in width. Development consists of four adit levels, from 60′ to 300′ long, with several raises and stopes. Specimen rock was mined and worked in a mortor by

means of a spring pole. No equipment excepting a blacksmith shop and few tools.

Bondurant Quartz Mine. This property consists of about 1000 acres located in sections 24, 25 and 36, T. 2 S., R. 17 E., M. D. M., about 12 miles northeast of Coulterville and on the North Fork of the Merced River. There are 100 acres of patented mineral land, 740 acres of patented timber land, two tunnel locations and one mill location. Owned by A. L. Adams, 302 Center street, Bridgeport, Connecticut. The claims were originally located in 1855, and worked for several years, the ore being milled in an arrastra. In 1870 an eight-stamp mill was built, and in 1887 a new ten-stamp mill was constructed. This was run for about five years, when it was closed down, and remained closed for some 23 years. In 1914, five men were working doing development work. There has been no activity in the last few years. Lack of water, long distance to tram the ore, and hard quartz, were the difficulties. There are several quartz ledges, varying from four to fifteen feet in width, and all of them between slate walls. The general strike is northwest and southeast and the dip is about thirty-five feet northeast. There are three principal producing veins, called the Bondurant, Reynolds and Louisiana. The ore is hard white quartz, carrying gold, silver, lead and zinc. Development consists of a 412 foot incline shaft, another 125 foot shaft, about 1000 feet of drifts, 945 foot crosscut tunnel on the river level, 225 foot crosscut on adit level, 150 foot raise and several stopes. It is planned, when operations are renewed, to construct a mill on the North Fork of the Merced River and work the mine through the long river level tunnel. This is expected to cut the vein when driven 200 feet further, and will give 1000 feet of backs on the dip of the vein.

Present reduction equipment consists of a ten stamp mill, two 4′ x 16′ plates, 2 Union concentrating tables, rock breaker, 2 Challenge feeders, 35-h.p. steam engines, 60-h.p. boiler and several pumps. At the hoist there is a double 8 x 12 link motion, hoisting engine and a 14 x 42 tubular horizontal boiler. The topography is rolling, fairly rough, elevation 3000 feet, and timber plentiful. Several mill buildings, two blacksmith shops, bunk house, etc. The ore is said to average around $8 per ton.

Booth Quartz Claim. (See Mariposa County Report 1915 page 151.)

Bouvier (Carson.) Located in Hunter Valley in sections 3 and 4, T. 4 S., R. 16 E., M. D. M., 12 miles north of Hornitos. Old shaft 125 feet deep, with several other shallow prospect shafts. An old five-stamp mill was operated here in 1868, but it burned down, and the property has not been worked since. Consists of 483 acres of agricultural land, and several mineral claims. Temperance Creek flows through the property. The shaft is located on a cross vein, about 150 feet west of the main ledge so-called "Blue Lead." The Blue Lead varies from two feet to twenty feet in width and the cross veins from two to four feet. The hanging wall is chert and the footwall porphyrite.

Bowman Quartz Claim. (See Mariposa County Report, 1915, page 151.) Not worked for years.

Bryan Mine. (See Silver Mine.)

Buena Vista. (See Busch.) Formerly owned by L. F. W. Busch, of Mariposa, now owned by Mrs. L. C. Brice. Located in section 21, T. 4 S., R. 18 E., M. D. M., in the Colorado district about 7 miles north of Mariposa. No equipment, and has not been worked for some time.

Buffalo. (See San Domingo.)

Cader Idra. (See Emma Quartz Mine.)

Bull Dog Quartz Claim. Owned by Theodore Kokel, and located in the Whitlock district in section 31, T. 4 S., R. 18 E., M. D. M., 6 miles northwest of Mariposa. The claim was located in 1894. The vein is from 2 feet to 4 feet in width, between porphyry walls. There is a shaft about 40 feet deep and a windlass and bucket. Only assessment is done each year.

Bull Pup Quartz Claim. Owned by Jack Czerney of Merced, located in the Whitlock district in section 31, T. 4 S., R. 18 E., M. D. M. Located in 1894. There is a 65-foot incline shaft and 100-foot drift on the vein. Vein is from 2 feet to 4 feet in width, between porphyry walls, strikes northwest and southeast and dips 80 feet northeast. Not worked for several years.

Bullion Hill. Located in the Hornitos District, 5 miles north of Hornitos. It was reported (April, 1920) that a small mill was being installed on this property.

Bunker Hill Quartz Claim. (Squirrel Mine.) Owned by Harry Taylor. Located near Hiter Cove, on the North Fork of the Merced River, about 6 miles west of El Portal. It is said to have had the first quartz mill in the state in 1851, with wooden stamps. The mine was discovered by quartz brought to the surface from a squirrel hole, and was called the Squirrel Mine. Formerly owned by Charles Lewis. Considerable old development work was done. There has been some recent activity, and it is reported that the owner is considering putting in a Gibson mill.

Busch Quartz Mine. T. F. W. Busch of Mariposa formerly owned three claims in section 21, T. 4 S., R. 18 E., M. D. M., in the Colorado district about 7 miles north of Mariposa. Two of the claims were sold, but Mr. Busch still owns the Talc claim, which was located in 1904. The quartz ledge is between slate walls and is about nine feet in width. It has not been worked for years. (See Washington No. 1 and Buena Vista.)

Carrie Todd Mine. Located in the Bull Creek or Kinsley district in sections 7 and 9, T. 3 S., R. 18 E., M. D. M., 2 miles west of Kinsley. It is near the top of the precipitous east bank of North Fork of the Merced River. Owned by Mrs. Hannah Douglas of Denver, and was located almost twenty years ago. Four claims, Carrie Todd (patented), West extension of Carrie Todd, Thanksgiving and Eugene (unpatented).

The vein is from 2′ to 4′ in width, between slate walls, strikes E. and W. and dips 75° N. There are three tunnels, the upper one 208 feet long, a second shorter one with a winze connecting it with the main tunnel below, which is several hundred feet long.

The ore carries considerable sulphides, including pyrite, sphalerite and galena, and is free milling.

There is a 3-stamp mill at the mine, built with great difficulty on the steep mountain side, a Joshua Hendy 2-stamp mill, and a separate one-stamp, with plater, Dodge crusher, Pindas concentrator, a 25-h.p. gasoline engine, compressor, and a second 75-h.p. gasoline engine, taken from an old tractor.

The mine was bonded in 1919 by Milton Fraser of Kinsley and Mr. Sain of Coulterville. Mr. Sain has since given up his bond. Extensive developments are planned by Fraser, namely a 10-stamp mill on the bank of the North Fork, with a 2500-foot tramway from the mine, a large compressor, etc. A ditch line has been surveyed for water power to run the mill. Part of the mill machinery was, in October, 1919, on the ridge awaiting difficult transportation down to the river.

Castagnetto Mine. Located in Hunter Valley, in section 15, T. 4 S., R. 16 E., M. D. M., about 10 miles north of Hornitos. About 4 miles by trail to Bagby. Owned by the Castagnetto Estate. Leased a few years ago to Chas. Burt and Dr. Dodge, who did some work, but their lease expired in 1916 and it has not been worked since. There is an incline shaft 150 feet deep, with drifts 100 feet E. and 60 feet W. on the 70-foot level.

The vein is between porphyry walls and is about 18 inches wide. It strikes NW. and SE. and dips SW. There is considerable ore on the dump which it is claimed will run $10 per ton.

The mouth of the shaft is on a hillside about 100 feet above Cotton Creek, which stream, together with the mine water, would furnish enough for a small mill.

Champion Mine. Consists of one unpatented claim owned by G. E. Dunbar of Mariposa, and located in the Colorado district, in section 27, T. 4 S., R. 18 E., M. D. M., 6 miles north of Mariopsa, and 23 miles from Bagby. There are two quartz veins which average 4 feet in width, and which lie between a porphyry footwall and a slate hanging wall. They strike E. and W. and one dips 70° S. and the other is almost vertical. Development consists of a shaft 96 feet deep, with two levels, one at 60 feet and one at 90 feet. There is a drift 50 feet west on the 60-foot level, and one 78 feet east; and one 60 feet west on the 90-foot level. There are shallow prospect shafts for 1300 feet on the surface.

There is no equipment at the mine, and assessment work only has been done for several years. There is very little water, except what is in the mine, and the timber is not plentiful. Elevation is about 2800 feet.

Champion Mine. Owned by Mrs. Wagner, Mrs. N. C. Kay and Mrs. M. A. Mentzer, and located 2 miles north of Coulterville, in section 28, T. 2 S., R. 16 E., M. D. M. Nearest railroad station is Pleasant Valley on the Yosemite Valley Railroad, which is 12 miles distant. It is on the bank of Black Creek at an elevation of 1650 feet. The quartz vein is from 6′ to 12′ in width and lies between slate walls. It strikes N. 17° E. and dips 45° SE. The ore is free milling quartz, containing galena, sphalerite and tetrahedrite.

Development consists of an incline shaft 250 feet deep, a second shaft 200 feet deep connected with the first drifts, and there are several stopes.

When visited in October, 1919, there was a fully equipped 10-stamp mill on the property, with hoist, etc. It has since been reported that the National Gold Mines Company of Los Angeles purchased the machinery and is to remove it to another property. Several years ago, C. I. Mentzer, of Coulterville, and others leased the property, and milled several thousand dollars worth of ore which averaged around $45 per ton. The ore was milled in the Potosi mill. Soon afterwards a Los Angeles company leased the mine and put up the mill, which was very poorly constructed. Both the Pacific Gas and Electric and the San Joaquin Light and Power Company's lines cross the property.

Cherokee. (See Lovely Rogers.)

Cohen Quartz Claim. (See Mariposa County Report 1915, page 153.)

Colorado Quartz Mine. Consists of three claims, the Colorado Quartz, patented, the Colorado Extension, and the Colorado No. 2, unpatented, owned by P. W. Weston and J. L. Dearborn of Mariposa. Located in section 27, T. 4 S., R. 18 E., M. D. M., in the Colorado district, about 7 miles north of Mariposa and 22 miles by wagon road from Bagby, on the Yosemite Valley Railroad. Saxon Creek Station on the Yosemite Valley Railroad is 3½ miles northwest by trail. The elevation is 3000 feet and the topography fairly rough and steep. Timber is plentiful and sufficient water for milling is obtained from Long Gulch.

The vein is a true fissure vein between slate walls and will average 2½ feet in width. At the bottom of the shaft it is 7 feet wide, and in the lower level it is 2½ feet wide and has been exposed for a distance of over 200 feet. It strikes NW. and SE. and dips from 60° to 80° NE.

The development consists of an adit level 500 feet long, a 140-foot raise and a 125-foot shaft. There are two levels below the tunnel, one at 30 feet and one at 100 feet, on both of which 200-foot drifts have been run along the vein. There is a stope 120 feet long and 25 feet high.

There is a 10-stamp mill, two 5′ x 10′ plates, crusher, Challenge feeders, 2 Gates concentrating tables and 2 vanners. Also a 2-drill Rex compressor and 2 machine drills.

Power is furnished by 2 Fairbanks-Morse gas engines, one 15-h.p. and 12½-h.p., also 3 Doaks gas engines, one 30-h.p. and two 5-h.p. There is a blacksmith shop, assay office, bunk house, change house, and other buildings.

About 2500 tons of ore have been milled, which averaged $10 or $11 per ton. Some development rock went $8 per ton. The ore is a banded quartz and is free milling. The mine has not been operating since late in 1918, at which time Mitchell and Ward had a lease and bond on the property.

Comet Gold Mine. Formerly owned by the Comet Gold Mining and Milling Company of Kansas City, now owned by W. A. Moses, 428 South Oxford street, Los Angeles. Located in the Jerseydale district, in section 22, T. 4 S., R. 19 E., M. D. M., about 15 miles northeast of Mariposa. Elevation 3600 feet and topography rough and steep. Timber is plentiful, and there is a good supply of water from Keefer Creek, near by. There are three claims, none of them patented, located

in 1875 by Daniel Heaton. Bonded to a Mr. Grayson in 1896. Worked from 1911 until March, 1913. Again worked from August, 1914, until first part of 1915. In 1917 a Mr. Campbell of Fresno had an option on the property and worked for several months, but did not mill any ore. In the first part of 1918 Mitchell and Cooper worked on an option for about 3 months and took out several hundred tons of ore but never milled it. When visited in October, 1919, there was 700 or 800 tons of ore in the ore chute. The mine has not been worked since 1918.

There are two veins on the contact between a granite and quartzite footwall, and a slate hanging wall. The granite footwall changes to quartzite in the back of the tunnel. The vein matter is free milling quartz and varies from 2′ to 4′ in width, averaging about 2½ feet. It strikes NW. and SE. and dips about 85° NE. There are some small faults and dikes.

Development consists of two tunnels, the lower one 750 feet long and the upper one 285 feet. There is a 100′ crosscut in the lower level and a 40′ raise. From the upper level there is a raise 168′ to the surface, and a winze 45′ deep. No stopes.

The equipment consists of a 10-stamp mill in good condition, 1250-pound stamps, Blake rock crusher, Challenge feeders, 2 plates, 4′ x 12′, 2 Deister tables and steam engine. There is an ore chute 300 feet long from upper tunnel to the bin at the lower tunnel.

There is also a sawmill on the property, equipped with a 45-h.p. steam engine, 60-h.p. boiler, circular saw and other equipment. The steam is piped from the boiler, a distance of 300 feet, in a 4″ pipe to the mill. The ore is said to average $8 per ton and will plate $4 per ton. About 2½% sulphides.

The entire property, mine, mill and all equipment, was for sale at a price around $5,000. The machinery, excepting engines, was for sale at a price around $2,500. F. M. Shelton is agent and caretaker at the property.

Compromise. (See Marble Springs Mine.)

Cranberry Quartz Mine. Consists of one patented claim, owned by A. H. Ward, 53 Stevenson street, San Francisco, and located in section 15, T. 3 S., R. 19 E., M. D. M., about 2 miles northeast of Clearing House on the Yosemite Valley Railroad, and 6 miles from El Portal. A trail leads from the Merced River northward, to the mine.

Elevation about 3000 feet, topography rough. The claim was located in 1863 and patented in 1873. There is one fissure vein between slate walls, which varies from 3′ to 6′ in width, strikes NW. and SE. and dips 70° NE.

Development consists of a shaft 110 feet deep, a tunnel 1240 feet, along the vein, a 300-foot winze and a 460-foot raise. No stopes. There is no reduction equipment.

The claim has not been worked for 25 years. The owner holds an old water right on the Merced River for 1500 inches for a fall of 70 feet. (See Rutherford Quartz Mine.)

Crown Lead Gold Mine. One patented claim, the Crown Lead, owned by the estate of Mary P. MacCerellish; W. P. Edwards, manager, Alameda. Located in sections 26 and 36, T. 3 S., R. 16 E., M. D. M.,

on the east bank of the Merced River at Kittridge Station on Yosemite Valley Railroad about 3 miles below (northwest from) Bagby.

The elevation is 2000 feet, topography very rough and steep. No timber and no water except from the mine.

The quartz vein is on the contact between slate hanging wall and serpentine footwall, and is 10 feet in width, striking NW. and SE. and dipping 65° NE.

Development consists of a 50-foot incline shaft and a 75-foot tunnel, both of which have caved. There is no equipment at the property, and it has not been worked for many years. It was bonded several years ago to the Crown Lead Gold Mining, Milling and Transportation Company, of New York, but the bond lapsed in July, 1914.

Crown Peak Quartz Mine. Consists of one patented claim, the Crown Peak, owned by the estate of Mary P. MacCrellish; W. P. Edwards, manager, Alameda. Located in section 36, T. 3 S., R. 16 S., M. D. M., 2 miles by trail from Kittridge Station on the Yosemite Valley Railroad, and just south of the Crown Lead. It is on the crest of the steep ridge which rises from the east bank of the Merced River, at an elevation of over 2000 feet. There is no timber and no water. There are two quartz veins on the contact between a serpentine footwall and slate hanging wall. They vary from 6′ to 8′ in width, and strike NW. and SE., with a dip of 65° to the NE.

Developed by a 45-foot incline shaft and a 50-foot open cut.

No equipment at the property and it has not been worked for 40 years.

Diana Group. Consisted of four claims, Diana Nos. 1, 3, 4 and 5, located in section 24, T. 2 S., R. 17 E., and sections 30 and 31, T. 2 S., R. 18 E., M. D. M., and formerly owned by Diana Mining Company of San Francisco. Some of the land relocated and now included in the Bondurant group. (See Bondurant.)

Diltz Quartz Mine. Located in section 29, T. 4 S., R. 18 E., M. D. M., in the Whitlock district, 6 miles northwest of Mariposa. Owned by Mrs. Jennie Diven. Elevation 2850 feet, topography fairly rough. Timber plentiful and water from springs. Two claims, the Diltz, patented, and W. Y. O. D., unpatented, total 29½ acres. Located in the 60's by Diltz, then passed to Diltz estate, to Hugh Devaney, to Devaney estate, to S. J. Harris, by purchase, then to Diven.

The quartz vein is on the contact between a porphyry footwall and a slate hanging wall, and averages about 20 inches in width, 10 inches of "ribbon quartz" and 10 inches of "bull quartz." It strikes NE. and SW. and dips 45° SE.

In October, 1919, two men were working, driving a tunnel to tap the ledge. The tunnel was then 300 feet long. Excessive cost of supplies was holding back development. Other development consists of a short drift, a crosscut about 60 feet long, and a winze in which water was struck, preventing further progress.

Equipment consists of a 6″ x 6″ double-cylinder air compressor, 20-h.p. gasoline engine, a small skip and a blacksmith shop.

The property was under bond in 1914 to C. A. Schlageter and T. L. Diven, as the Mariposa Mines and Development Company, who did some development work and shipped some ore. No ore has been taken out since 1914. The ore is said to average $8 per ton, some running $20 per ton.

Doss and Thorne Mine. Owned by L. A. Ginaca and C. Ginaca, 213 Rialto Building, San Francisco. Located in section 28, T. 5 S., R. 16 E., about 3 miles southeast of Hornitos. One full claim, the Doss, and one fraction, the Thorne. The quartz vein is thirty feet wide between diorite schist walls, and strikes northeast and southwest. The ore is white quartz, carrying a very high per cent of sulphides, with two feet of practically solid sulphide on the footwall. The ore is said to assay from $12 to $20 per ton. There is a 400-foot shaft and an adit level 475 feet long, with crosscuts every fifty feet. One level in the shaft at 200 feet, with 300 feet of drifts. No equipment on the property and no production to date. Expect to produce soon. (April, 1920.)

Duncan Mine. Situated about 1 mile southeast of Hornitos, in sections 16 and 21, T. 5 S., R. 16 E. This is a "pocket" mine, located in the porphyrite and amphibolite schist, and has been owned for many years by George B. Turner. It is operated occasionally by leasers. In March, 1920, it was reported that a pocket of gold, valued at over $1,000, was uncovered by Dave Oneto and Mr. Tura, of Jackson, Amador County, who were operating it.

Early Quartz Mine. Consists of one unpatented claim owned by Eli Revel and the estate of August Revel, and located in the Sweetwater district in section 27, T. 4 S., R. 19 E., M. D. M., about 16 miles by wagon road northeast of Mariposa. Elevation 3700 feet, topography very rough and steep.

The quartz vein is between granite walls and varies from three to five feet in width, strikes N. 25° and dips 60° SE.

Development consists of a tunnel 800 feet long, above which the ore has been stoped out to a height of 100 to 500 feet, for the entire length. There is a forty-foot crosscut tunnel. The mine has had a varied history during the last few years. It was first leased by J. C. Yancy, then by Mrs. McIntyre, and then by Mr. Robinson. A company headed by Robinson installed considerable machinery, but most of it has recently been removed by the Schaw-Batcher Company and the Chicago Pneumatic Tool Company for nonpayment of bills.

The Robinson Company ceased operations in January, 1918, but about thirty men were left to work the mine for their wages. They worked the property until December, 1918. It is understood that Robinson sold his interest to a Mr. L. I. Sussman of 112 Market street, San Francisco. Early is now (April, 1920) suing for possession.

El Carmen. (See Mexican.)

Elizabeth Quartz Mine. Owned by the Mariposa Commercial and Mining Company, E. H. Benjamine, president, 522 Nevada Bank Building, San Francisco. Located in section 5, T. 5 S., R. 17 E., on the Mariposa Grant, 16 miles by wagon road from Merced Falls on the Yosemite Valley Railroad and 7 miles west of Mount Bullion.

Elevation 1500 feet, topography fairly rough, some oak timber, and water supply from Corbett Creek. The vein is on the contact between a slate footwall and porphyry hanging wall, averages six feet in width, with a maximum width of twenty feet. It strikes northwest and southeast and dips 50° E.

Development consists of a shaft 100 feet deep, about 100 feet of drifts, and a stope 100 feet high by five feet square.

Equipment consists of a 40-h.p. boiler, hoist, blacksmith shop, ore car, tracks, etc.

The property has not been worked since 1911. Before that time it was worked by leasers, who hauled the ore to the Princeton Mill at Mount Bullion. The average value of the ore is said to have been $19 per ton.

Emma Quartz Mine. Formerly known as the **Cader Idra.** Owned by Marcus Shinskie, and located in section 36, T. 3 S., R. 19 E., M. D. M., on the South Fork of the Merced River in the Hite Cove district. El Portal is about 6 miles northeast. Originally located about 1870, but later abandoned, and one claim, the Emma, relocated in January, 1914, by Marcus Shinskie.

Elevation 3500 feet, topography very rough, not much timber, and only water enough for domestic ore in the summer, but plenty in the winter.

There are two veins, one a free milling, ribbon gold quartz, and the other a silver-bearing quartz. The veins are between slate walls, strike NW. and SE. and dip 75° NE. They vary greatly in width, as they swell and pinch.

Development consists of a tunnel driven 90 feet on the vein, two other tunnels now caved, and several raises and stopes. Last few tons of ore milled is said to have carried very high values. The silver ore is base and hard to work.

No equipment on the property and only assessment work has been done in the last few years.

Farmers Hope. (See Miners Hope.)

Feliciano Quartz Mine. One patented claim, the Feliciana, owned by Mrs. J. B. Campbell of Fresno. Located in sections 12 and 13, T. 4 S., R. 18 E., M. D. M., in the Colorado district, about 10 miles by wagon road north of Mariposa, and four miles by trail southeast of Briceburg on the Yosemite Valley Railroad.

Elevation 3600 feet, topography rough, plenty of timber, and water from the mine and from springs.

There is one quartz vein, between slate walls, which varies from 2½′ to 3½′ in width; strikes NW. and SE, and dips 75° SW. Development consists of a tunnel 700 feet long, with a drift 350 feet south, and 250 feet north, along the vein, a 400-foot crosscut tunnel, and two winzes. Ore has been stoped out to the surface, a height of 650 feet for a length of about 700 feet.

The property has been idle for thirty years. During the last three or four years it has been under lease to J. B. Coyle of Fresno, who has worked it at intervals. He has been endeavoring to sink a shaft, but the water makes operation difficult. Equipment consists of a gasoline engine and a Straub rotary mill. There was formerly a 10-stamp mill on the property, but this has been taken away.

Ferguson. (See Anderson.)

Fournier Lease. Will Fournier and T. B. Fournier (brothers) early in 1915 obtained a lease on a prospect near the Princeton Mine, at Mount Bullion, owned by the Mariposa Commercial and Mining Company (Mariposa Grant). It is situated about 1000′ from the main Princeton

vein on the hanging wall side, and has been developed by a shaft 100 feet deep, 500 feet of drifts, and several small raises, crosscuts, and stopes. The property was worked quite steadily by the Fournier Brothers, until early in 1918, when one of them died. It was afterwards worked by Fournier and Marre. The unusual occurrence and high grade of the ore here are exceedingly interesting.

Rich pockets of ore were encountered, 40 or 50 pounds to the pocket, which ran from $8 to $20 per pound. The pockets seemed to collect around short stringers of pyrite, on a slate core, which projected from the slate wall into the vein. These stringers were from one inch to 6 or 8 inches long, from ½″ to 1″ wide and generally flat. One of these stringers is on exhibition at the museum of the State Mining Bureau.

The pockets were not encountered at regular intervals, nor were they very close together. Total production has been in the neighborhood of $10,000. Last production of record was in August, 1919, $745.

Equipment consists of 10-h.p. motor, pump and hand mortar.

Garden Placer Mine. Owned by Will D. Weston, and located in the Whitlock district, in section 32, T. 4 S., R. 18 E., M. D. M., 6 miles northwest of Mariposa and 5 miles by trail to Saxon Creek station on the Yosemite Valley Railroad. The claim is patented and is worked only in the winter time when the water is plentiful, about three months each year. The deposit is bench gravel, 4 to 10 feet thick, with pay gravel from 14 inches to 4 feet thick.

Worked by means of Pole and Hungarian riffles, with a grade of 7″ to 12′ boxes, quicksilver in the riffles.

Geneva. Owned by Mrs. C. A. Queriolo, 892 Isabella street, Oakland, on patented agricultural land in Hunter Valley, in section 10, T. 4 S., R. 16 E., 12 miles north of Hornitos.

Developed by a 60-foot shaft which has now caved. There is a small hoist and compressor. The property was worked a little some time ago.

Geary Mine. Owned by Mr. Potter of San Francisco. Located in section 30, T. 4 S., R. 18 E., M. D. M., in the Whitlock district, 6 miles northeast of Mariposa, and 5 miles by trail south of Saxon Creek station on the Yosemite Valley Railroad.

Elevation 2800 feet, topography fairly rough, very little timber, and water only from the mine. There is one vein on the contact between a slate footwall and a porphyry hanging wall. It averages 3 feet in width, strikes NW. and SE. and dips 80° NE.

There is an incline shaft 100 feet deep, also about 325 feet of drifts. No equipment. The mine has not been worked for years. It is said to be one of the most promising in the district.

Golden Gate Group. Owned by Chas. A. Schlageter of Mariposa. Located in sections 18 and 19, T. 4 S., R. 17 E., M. D. M., 1 mile northwest of Bear Valley and 7 miles by wagon road south of Bagby on the Yosemite Valley Railroad.

Two quartz veins on the contact between mariposite footwall and slate hanging wall. The veins vary from 3 to 6 feet in width, strike NW. and SE., and are almost vertical.

Development consists of a shaft 210 feet deep, an adit level 250 feet long, a 250-foot crosscut, and a 20-foot raise.

There is a blacksmith shop and a shed over the shaft, also small skip, wood track, etc.

The ore is said to assay from $7 to $20 per ton. Some ore on the dump.

Grant. (See Mariposa Grant.)

Gray Eagle. (Blue Jay.) Consists of two claims, the Gray Eagle, located in 1894, and the Stella, in 1912, owned by J. S. Gazolo. Situated in section 30, T. 3 S., R. 17 E., M. D. M., in the Flyaway district, about 4 miles by wagon road north of Bagby. Elevation 1700 feet, topography fairly rough, water only from the mine.

There are two veins on the contact between a serpentine footwall and porphyry and slate hanging wall. The vein strikes NW. and SE., and dips about 52° NE.

Developed by a shaft 133 feet deep, and adit level 200 feet long, 155 foot drift on the second level, 300 foot crosscut on the adit level, one stope 60′ x 20′ x 40′ high, and a second stope 60′ x 12′ x 35′ high.

The property was bonded in 1914 to some Los Angeles people, but little work was done.

Green's Gulch Quartz Mine. Owned by the Mariposa Commercial and Mining Company (Mariposa Grant). One patented claim located in sections 12 and 13, T. 5 S., R. 17 E., M. D. M., near Mt. Bullion and 12 miles by wagon road from Bagby.

There is one quartz vein averaging 3 feet in width, between slate walls. Strike NW. and SE. and dip about 50° NE.

Development consists of a 300 foot shaft, with 3 levels, a 550 foot adit level, 510 foot drift on 1st level, 360 foot drift on 2nd level. There is a 200 foot crosscut, about 250 feet of raises, and a stope 200 feet long, 200 feet high and 3 feet wide.

Equipment consists of hoist, bucket, 2 machine drills, 2 pumps, and an air receiver. Compressed air is furnished from the Princeton mine.

The mine has been worked principally by leasers, but has not been in operation since January 1915. The ore is said to average about $11 per ton. Total production has been about 10,500 tons valued at nearly $120,000.

Grimshaw. (See Ruth Pierce.)

Guadalupe Quartz Mine. Consists of one patented claim, owned by the Mariposa Commercial and Mining Company, and located near the south line of the Mariposa Grant, in section 32, T. 5 S., R. 18 E., 4 miles south of Mount Bullion, and 17 miles southeast of Bagby on the Yosemite Valley Railroad.

The quartz vein is 18″ wide in granite, strikes NW. and SE., and dips E. about 25°. There is a 250 foot tunnel and some other underground workings.

The mine has not been worked by the company for many years, but leasers have at various times worked it. It has been idle since the latter part of 1914.

There is no equipment at the property.

Guest Quartz Mine. (See Mariposa County Report, 1915, page 57.)

Hasloe Quartz Mine. Owned by F. C. Morgan of San Francisco, and located in section 1, T. 3 S., R. 17 E., M. D. M., about 12 miles by wagon road east of Coulterville.

There is one quartz vein, from 1′ to 3′ in width between slate walls. It strikes E. and W. and dips about 30° N.

Developed by a 300′ incline shaft. This property has been idle for nearly 40 years.

Herman Quartz Mine. Formerly consisted of two claims owned by George Herman of Mariposa. The claims were allowed to become delinquent and one of them has been relocated by a Mr. Ives. Located in section 29, T. 4 S., R. 18 E., in the Whitlock district 6 miles northwest of Mariposa.

Two veins in porphyry, each averaging about 10′ in width. Developed by a tunnel, and a 110′ drift on one vein and a 100′ drift on the second. Has not been worked for some time.

Hite Gold Mine. Situated at Hite Cove on the South Fork of the Merced River, in section 27, T. 3 S., R. 19 E. Clearing House, on the Yosemite Valley Railroad, is 4 miles northwest by trail, and there is also a siding, called South Fork, at the Junction of the South Fork with the main Merced River. El Portal is about 6 miles northeast. The property consists of fifteen quartz claims, three of which are patented, and one placer claim owned by J. S. Spilman, 244 Kearny street, San Francisco, who is also secretary and treasurer of the Mountain King Mining Company. The claims were located about 1863 and during the next 20 years there was considerable activity in the district, a town of several hundred people being located there. The mines were closed down in 1882 and very little work has been done since. Water was pumped out in 1896 and again in 1901, and some development work done, but no production has been made since the early days.

The Hite mine is credited with a production of close to $3,000,000, most of which was taken from near the surface.

There are two veins which average 4 feet in width between diorite walls, general strike a little N. of W., and dip about 75° NE. The quartz is free milling and averages 1½% sulphides.

The underground workings are quite extensive but some of them are now caved and inaccessible. There is a shaft 330′ deep with 3 levels, and there are also 9 adit levels, with several winzes and raises and a stope 800′ high.

There is a completely equipped 10 stamp mill and a cyanide plant all in poor condition from disuse, and the buildings are falling to ruin. The mill consists of 10 stamps, 2 Challenge feeders, 2 plates, 4′ x 16′, and 3 tables. There is an air compressor, air hoist, several machine drills, pump, etc. Also a flume 500 feet long, and ditchline, to take the water from the South Fork for power.

C. Arkell is caretaker at the property.

In Yosemite National Park.

Horse Shoe Mine. Located in Hunter Valley, in section 23, T. 4 S., R. 16 E., 10 miles north of Hornitos. About five miles by trail to Bagby. Elevation about 1800 feet, on a steep hillside, with pine and oak timber, water in Cotton Creek 100 feet or more below the shaft. The country rock is porphyrite.

There is an old shaft, said to be several hundred feet deep, which is now caved. There was a mill on the property, years ago, but no equipment now remains. Considerable ore still on the dump. This mine was worked to some extent many years ago.

Josephine Quartz Mine. Consists of one patented claim, the Josephine, owned by the Mariposa Commercial and Mining Company, E. H. Benjamin, president, 522 Nevada Bank Building, San Francisco. Located on the Mariposa Grant in section 16, T. 4 S., R. 17 E., 3 miles southeast of Bagby. One of the largest mines belonging to the company. Elevation 2100′, topography rough, not much timber, and water from Bear Creek. There is one quartz vein, which averages 6′ in width, between slate walls. It strikes NW. and SE. and dips about 55° NE.

Underground developments are quite extensive, consisting of a 500′ shaft with 4 levels. There are 1600′ of drifts on the first level, 100′ on the second, 600′ on the third, and 220′ on the fourth. There are also 710 feet of crosscuts, 400 feet of raises, and a stope 500′ x 200′ x 4′.

Equipment consists of a compressor, 2 drills, mine cars, 2000′ of track, 30-h.p. motor, blacksmith shop and other buildings. Electric power from the company's power house at Bagby. The mine has been worked mostly by leasers, and is credited with a total production of close to $1,000,000. Has not been worked for the last few years.

Frank Maguire of Mount Bullion, superintendent.

Bibl.: Mineral Resources West of Rocky Mountains, J. Ross Brown, 1867, p. 42.

Jumbo. (See Blue Belle.)

Kane Quartz Mine. Consists of one unpatented claim, formerly called the Mayflower, owned by C. N. Kane of Mariposa, and located in section 2, T. 5 S., R. 19 E., about 12 miles northeast of Mariposa. Elevation 4000 feet, topography very rough, plenty of timber and water from Snow Creek. There are two tunnels, one 60′ and the other 140′ long. No equipment. Not worked during last few years.

Kenedy-Milburn-Allerd Claim. Three unpatented claims owned by C. L. Kenedy, W. H. Milburn and Lawrence Allerd of Mariposa. Located on the South Fork of Chowchilla River, 2 miles east of Indian Peak, ½ mile south of Nelson's Cove, and 12 miles northeast of Raymond, Madera County.

The vein is about 9′ wide and strikes NE. and SW. Developed only by 40′ adit level. The claims were located in May 1914 and only assessment work has been done.

Lafayette Mine. (Formerly called the **Ghirardelli.)** Owned by Dr. C. A. Queriolo, 892 Isabella street, Oakland, on patented agricultural land in Hunter Valley, in section 15, T. 4 S., R. 16 E., about 12 miles north of Hornitos.

The country rock is porphyrite and the vein is on the Hunter Valley so-called Blue Lead.

The mine was operated in 1866-67 and has been idle since then. The shaft was sunk to a depth of 150 feet, or about water level. It is claimed the vein at the bottom of the shaft averaged two feet in width and flated $25 per ton, no concentrates being saved. There was a 4-stamp mill then on the property, but that was taken away years ago. All that remains to be seen is the old shaft, now partially filled.

Landrum Quartz Mine. Consists of three unpatented claims, owned by Simeon Landrum, and located in sections 34 and 35, T. 4 S., R. 18 E., in the Colorado district, about 5 miles north of Mariposa. Six miles by trail north to Briceburg on the Merced River. Elevation 2900′, topography fairly rough, timber plentiful, and water from Saxon Creek and springs.

There are 3 veins averaging 2′ in width, between a limestone and talc footwall and a porphyry hanging wall. The general strike is NW. and SE., and the dip 45° SW.

Development consists of a 90′ shaft and over 800 feet of drifts. Equipment consists of a 2-h.p. gas engine, windlass and bucket. There are two cabins and a blacksmith shop. It was intended to install a stamp mill and the buildings were erected, but the machinery is not yet in place. No recent operation.

Little Bear Quartz Mine. (Formerly known as the **Pete Gordon.**) Consists of one unpatented claim, owned by Charles J. Hayes of Mariposa and located in section 19, T. 4 S., R 19 E., between Sweetwater and Colorado. Elevation 3000′, topography rough, not much timber, plenty of water from Little Bear Creek.

There are three veins, the main one averaging 2′ in width and reaching a maximum of 6 feet. The veins are on the contact between a slate footwall and granite hanging wall, have a general strike of NW. and SE. and dip 45° NE. The ore is a free milling quartz.

Development consists of a 175′ adit level on one side of the creek, and a 30′ adit on the other side, and a 12′ winze.

Only assessment work is done, as Mr. Hayes devotes his time to ranching. He would bond the property to anyone with capital to develop it.

Live Oak Quartz Mine. Owned by George Trede, and located in section 16, T. 4 S., R. 18 E., ½ mile by trail south from Saxon Creek Station on the Yosemite Valley Railroad. Elevation about 1800′, topography rough, plenty of water from Bear Creek and from springs. Three unpatented claims, Live Oak, Live Oak Extension and the Ochre. There are two veins, averaging 20″ and 8″ wide respectively, on the contact between a greenstone footwall and a slate hanging wall. The strike is N. and S. and the dip 45° E. The ore is free milling quartz.

Development consists of four shafts, 20′, 30′, 40′ and 50′ deep, respectively; a 200′ crosscut and about 100′ of drifts.

Equipment consists of a 2-stamp mill, an old 16-foot arrastra, Pelton water wheel with a ditch line one-half mile long, gravity tramway, blacksmith shop, boarding house, and bunk house.

Work is generally carried on in the winter time when sufficient water, for power, is to be had. There has been nothing done in the last two years.

London Quartz Mine. Formerly called the **Young America.** Owned by O. H. Leonard, and located in section 30, T. 4 S., R. 18 E., in the Whitlock district, about 7 miles north of Mariposa and 5 miles by trail south from Saxon Creek station on the Yosemite Valley Railroad. Elevation 2670 feet, topography fairly rough, practically no timber and no water. One unpatented claim located in 1912 by Albert and L. E. Austin who owned the property for several years.

There is one quartz vein averaging 22″ in width between porphyry walls. It strikes NW. and SE. and dips 70° NE. The ore is base, carry-

ing copper and iron, with the gold values. There has been very little development, only a 30′ shaft and a short drift. No recent work has been done.

Long Mary Quartz Mine. Owned by the Mariposa Commercial and Mining Company, E. H. Benjamin, president, 502 Nevada Bank Building, San Francisco. Located on the Mariposa Grant, in section 17, T. 5 S., R. 17 E., about 4 miles west of Mount Bullion, and 14 miles by wagon road from Merced Falls on the Yosemite Valley Railroad.

Elevation about 1500 feet, topography rough, not much timber, water from Corbett Creek.

There is one quartz vein, averaging 2 feet in width between slate walls. Strikes NW. and SE., and dip 60° SW.

Underground developments are quite extensive, consisting of a shaft 413′ deep, a 263′ adit level tunnel, 360′ of drifts on 200 foot level, 383′ on 300 foot level, 315′ on 350 foot level, and 163′ on the 400 foot level, also over 900 feet of raises, and a stope 400′ high and 350′ long.

Equipment consists of a 5-stamp mill, 1000 pound stamps, rock crusher, Challenge feeder, plate 56″ x 10″, two Union tables, also a hoist, a 10″ x 12″ compressor, capacity 225 cubic feet per minute, two transformers, 150-h.p. each. The company has a branch power line 4 miles long, from the mine to the Bagby power line. There is a blacksmith shop, boarding house, and other buildings. The mine was worked to some extent in 1914 and 1915.

The ore is said to average around $12 per ton, the mine is credited with a total production of close to 10,000 tons.

Louis Quartz Mine. Owned by the Mariposa Commercial and Mining Company, E. H. Benjamin, president, 502 Nevada Bank Building, San Francisco. Located on the Mariposa Grant in section 11, T. 5 S., R. 17 E., 1½ miles northwest of Mount Bullion, and 12 miles by wagon road south of Bagby on the Yosemite Valley Railroad. Elevation about 2150′, topography rough, no timber and no water. There are two veins, averaging 4 feet in width, between slate walls. The strike is NW. and SE., and the dip about 50° NE. The ore is free milling quartz.

There is a 400′ shaft with two levels; 500′ of drifts on upper level and 424′ on the lower level. Also a 350′ adit level, a 115′ crosscut, 150′ of raises, and a stope 180′ x 80′.

Production has been about 1240 tons valued at $27,690, or slightly over $22 per ton.

With the exception of a few tons of ore occasionally taken out by leasers, the mine has not been worked since 1902. There has been no production since 1912.

Louisa Quartz Mine. Owned by Eli Revel and the estate of August Revel. Located in the Sweetwater district, in section 27, T. 4 S., R. 19 E., about 16 miles by wagon road northeast of Mariposa, and 7 miles by trail south of South Fork Siding on the Yosemite Valley Railroad. The topography is very rough, timber plentiful, and water enough from the mine for milling operations.

One unpatented claim, located in 1900. There is one quartz vein averaging 4′ in width, between granite walls. The strike is E. and W. and the dip about 80° S.

There is very little development, there being one tunnel 50′ long, another 60′ long and a small open cut. No equipment, and only assessment work is done.

Louise Quartz Mine. Owned by A. S. Bigelow and G. M. Hyans of Boston; formerly the Merced Gold Mining Company; C. I. Mentzer, of Coulterville, is superintendent. The mine is located at the edge of the town of Coulterville, in section 3, T. 3 S., R. 16 E. Pleasant Valley is the nearest railroad shipping point, about 12 miles southwest, on the Yosemite Valley Railroad. Elevation about 1700 feet, considerable timber, water from Maxwell Creek which runs through the property. The quartz vein in this district shows as a massive outcrop, 20 feet or more wide which can be traced for miles across the country along the crest of a series of rolling hills. Where Maxwell Creek cuts through the ledge at the western edge of Coulterville, a bold massive quartz outcrop is left on either side. When visited in October, 1919, the outcrop on the Louise property, on the north side of the creek, had shortly before been sampled by some Los Angeles engineers.

The mine has not been worked for many years but there is considerable underground development, consisting of a vertical shaft 375 feet deep, with three levels. There are 275′ of drifts on the 100′ level, 75′ on the 200′ level, 500′ on the 300′ level, 775′ of crosscuts, 150′ air shaft, and 600′ of winze on the vein.

There is no equipment at the mine, the ore having been formerly milled in the Potosi mill owned by the same company. The ore was hauled by means of a steam locomotive on a narrow guage track, with large ore cars. (See Merced Gold Company, and also Introduction.)

Louisiana Mine. Located in section 25, T. 2 S., R. 17 E., about 12 miles northeast of Coulterville, adjoining the Bondurant. It has not been worked for many years. Formerly owned by C. P. Treat, now under option to A. T. Adams, owner of the Bondurant. The vein is in slate and varies from 1′ to 5′ wide. It strikes N. 60″ W. and dips 45° NE. Incline shaft 275′ deep and a tunnel 150′ long.

Lovely Rogers Quartz Mine. (Cherokee.) One patented claim, the Lovely Rogers, and one unpatented claim, the Mount Quin, owned by Arthur Shimer, and located in section 11, T. 3 S., R. 17 E., about 9 miles east of Coulterville and 15 miles northeast of Bagby on the Yosemite Valley Railroad. The elevation is 2400 feet, topography rough, very little water and little timber. There are 3 veins varying from $1\frac{1}{2}$′ to 2′ in width between slate walls. The general strike is E. and W. and the dip 70° N.

There is a shaft 100 feet deep, and three adits, 400 feet, 300 feet and 250 feet long respectively. Also a 70 foot crosscut, a winze 80 feet deep, and a stope 200 feet long and 80 feet high.

No equipment. There formerly was a mill but it was moved to the Bondurant. Nothing has been done for the last several years.

Malone Mine. Formerly known as the **Bear Creek Gold Mine.** Located in section 5, T. 5 S., R. 19 E., about 7 miles northeast of Mariposa, and 6 miles by trail southeast of Briceburg on the Yosemite Valley Railroad. Under lease to Will Johnson. The property consists of five claims, all patented. Elevation 2600 feet, topography fairly level, plenty of water for the 20 stamp mill, from springs and mine. There

are six separate veins, averaging one foot in width, but reaching a maximum of 4 feet in width. All the veins are in granite, strike approximately N. and S. and dip 33° W. All have been proven for a distance of 1320 feet on the surface.

Development consists of a shaft 150 feet deep, an adit with a 600 foot crosscut tunnel, and a stope 300 feet long, 90 feet high, and 3½ feet wide.

There is a 10 stamp mill, five 1000 pound stamps, and five 650 pound stamps, Golden State rock crusher, Challenge feeders, and 2 plates 54″ by 84″.

Steam power is used with wood for fuel. There is an 80-h.p. boiler, also 20-h.p. mill engine, and 25-h.p. engine for the hoist.

Water is piped 2000 feet from a spring to a 4000-gallon concrete tank at the mill. There is a dwelling house, boarding house, bunk house and blacksmith shop.

Formerly worked to some extent by Thomas Gordon and associates. Now (October 1919) being worked by Will Johnson, who has been operating it for the last several months taking out $10 to $12 ore.

Malvina Quartz Mine. Owned by A. S. Bigelow and G. M. Hyans of Boston, formerly the Merced Gold Mining Company, now dissolved. C. I. Mentzer, of Coulterville, superintendent. Located in section 4, T. 3 S., R. 16 E., 1 mile west of Coulterville.

The mine was worked extensively in early days, the ore being hauled through the Potosi tunnel in ore cars pulled by mules, to the Potosi mill, owned by the same company.

Development consists of one vertical shaft 1000 feet deep, another incline shaft 875 feet deep, 1275 feet of drifts on the Potosi tunnel level, 400 feet of drifts on the 44 foot level, 387 feet on the 600 foot level, 225 feet on the 900 foot level, and 1225 feet of crosscuts.

There is a large Corliss, flat cable hoist and head frame, blacksmith shop, change house, office, etc.

The ore was low grade, averaging around $4 per ton, and with the equipment, could not be worked at a profit.

The property has been idle for many years. (See Merced Gold Mining Company; also Introduction.)

Mammoth. (See Quail.)

Marble Springs Mine (Compromise). Owned by J. A. Flink and R. C. Haywood, under the title of the Marble Springs Gold Mining Company. Located in the Kinsley district, in sections 30 and 31, T. 2 S., R. 18 E., about 14 miles by wagon road, east of Coulterville.

This old property is said to have had the first stamp mill in the state, consisting of wooden stamps. The property was idle for nearly 40 years, but during the last few years has been worked, off and on, first by Mr. Fillmore and associates, and later by J. A. Flink. The latter was working the mine in the latter part of 1919, employing several men, and crushing in a 30-ton Gibson mill, run by a gas engine.

There is one vein, varying from 2′ to 5′ in width, between a slate footwall and a diorite hanging wall. It strikes NE. and SW. and dips 47° SE.

There is a 350 foot incline shaft, with three levels, and about 1000 feet of drifts.

Elevation 2800 feet, topography very rough.

Mariposa Commercial and Mining Company. (See Mariposa Grant.)

Mariposa Grant. Owned by the Mariposa Commercial and Mining Company, 522 Nevada Bank Building, San Francisco; E. H. Benjamin, president; H. G. Stevenson, secretary; Frank Maguire, superintendent, at Mount Bullion. Property consists of 44,000 acres, extending along the Mother Lode, from the Merced River at Bagby to about 4 miles south of the town of Mariposa, and including the towns of Mount Bullion and Bear Valley. There are in all about sixty mines, or veins, from which some production has been made. The most important of these, the mines which have been extensively developed, are as follows: Alice, Green Gulch, Long Mary, Mariposa, Mount Ophir, Pine Tree, Josephine, Princeton, Queen Specimen, Stockton Creek, Texas and Turner. (See under the above names in text.)

There is a 40-stamp mill at the Princeton mine and an old 5-stamp mill at Bagby. A power house on the Merced River at Bagby supplies power to the different properties, and light to the towns and residences. The properties have not been operated for many years, except by a few leasers.

Mariposa Quartz Mine. Owned by the Mariposa Commercial and Mining Company (Mariposa Grant), E. H. Benjamin, president, 522 Nevada Bank Building, San Francisco. This is one of the most important of the Grant properties, and was formerly one of the largest producers in the county. Situated at the town of Mariposa in section 23, T. 5 S., R. 18 E. Elevation 1900 feet, topography rolling, little timber, and water from Mariposa Creek and Stockton Creek. Located in the early 50's, and patented in 1857. The mine is credited with a production of close to $700,000 for the thirteen years, 1900 to 1913, the greatest production being made from 1901 to 1905. It was also a large producer before 1900.

There are two quartz veins, called the North Fork and the West Fork respectively, which will average 5 feet in width. General strike in NW. and SE. and the dip from 60° to 70° S. Both walls are diabase.

There is a 1550 feet incline shaft, with 8 levels. Drifts as follows: on 275 foot level, 390′ E. and 400′ W., on 475 foot level, 400′ E. and 637′ W., on 625 foot level, 700′ E. and 600′ W., on 800 foot level, 322′ E. and 410′ W., on 970 foot level, 396′ E. and 412′ W., on 1200 foot level, 250′ E. and 400′ W., on 1400 foot level, 60′ E. and 50′ W., on 1550 foot level, 200′ E. and 130′ W.

The ore is all stoped out from the 800 foot level to the surface.

The mine has not been worked since 1915, and much of the equipment has been removed, and the underground workings have caved.

There is a 5-stamp mill with feeders and plates. A large mill was destroyed by fire, several years ago.

Electric power was used, supplied by the company's power house at Bagby.

Total operating cost in 1915 was approximately $4 per ton.

F. C. Maguire, of Mount Bullion, superintendent of Grant properties.

Mary Harrison Mine. Owned by A. S. Bigelow and G. M. Hyans of Boston, formerly the Merced Gold Mining Company, C. I. Mentzer, of Coulterville, superintendent. Located in sections 10 and 11, T. 3 S., R. 16 E., 1 mile south of Coulterville. This is one of the four large mines

owned by the parties named. (See Introduction.) Elevation 1930 feet, topography rough, water from Maxwell Creek and Black Creek.

There are two quartz veins, averaging about 7 feet in width, between slate walls. Strike NW. and SE. and dip about 50° NE.

There is a vertical shaft 1200 feet deep with 12 levels, and a total of nearly 5000 feet of drifts; also an incline shaft 800 feet deep, and many stopes, crosscuts and raises.

The equipment consists of four 60-h.p. steam boilers, large steam hoist with flat cable, compressor, rock crusher and bins, well equipped office building, and store house filled with all kinds of machinery parts and hardware. The ore was crushed and hauled over a narrow guage track, by steam locomotive and large ore cars, to the Potosi mill owned by the same people. The ore is said to have averaged from $7 to $12 per ton.

The mine has not been worked for fifteen years or more.

The entire property embracing 4 mines and all equipment, is for sale at a price around $75,000. (See Merced Gold Mining Company; also Introduction.)

Mexican Mine. (Formerly known as the **El Carmen.**) Owned by Frank H. Catherwood, and located in section 36, T. 3 S., R. 19 E., near the Hite Cove district, and about 6 miles from Jerseydale. This is an old mine and has not been worked for perhaps twenty years. The elevation is close to 4000 feet, topography rough, not much timber, plenty of water, in the winter, but little in the summer.

There are two quartz veins, varying from 2′ to 6′ in width between slate walls. Strike NW. and dip about 80° SE. The ore is "ribbon rock" and carries free gold. There is an incline shaft 150 feet deep and a total of 625 feet of drifts. No equipment.

Mebold Quartz Mine. Consists of one unpatented claim, owned by Fred Mebold of Jerseydale, and located on Sweetwater Creek, northwest of the Sweetwater mine. The vein is two feet wide in granite walls. There is a 50-foot crosscut tunnel and a few feet of drifts. Has not been worked for several years.

Merced River Quartz Mines. (Horse Shoe Bend Mines.) Consist of 13 unpatented claims owned by R. A. Keller, James Burns and Company, James Burns, president. Located in sections 15, 16 and 22, T. 3 S., R. 16 E., 3 miles south of Coulterville and one-half mile from Mast Station at Horse Shoe Bend on the Yosemite Valley Railroad. There are 4 veins varying from 1′ to 4′ in width between a slate footwall and a serpentine hanging wall. The strike is NW. and SE. and the dip 50° NE.

Development consists of a shaft 100 feet deep, with two levels and 210 feet of drifts; another shaft 90 feet deep and crosscut 230 feet long.

There was a 10-stamp mill on the ground, which was never erected, also two rock crushers, and a 25-h.p. gas engine. There is a boarding house, bunk house and dwelling. Not operated for years.

Merced Gold Mining Company. Now dissolved. Property owned by A. S. Bigelow, and G. M. Hyams of Boston. (See introduction and individual mines mentioned.)

Consists of 25 quartz claims, all but one patented, 7 mill sites, two 160-acre homesteads, and 160 acres of patented timber land.

Mineral land located in sections 3 and 4 and 10 and 11, T. 3 S., R. 16 E., and sections 32, 33 and 34, T. 2 S., R. 16 E., near Coulterville.

In the so-called West Belt are located the following claims: Boston, Mahoney, Glendive, G. Douglass, Miles, D. Cook, Helena, Potosi, Ninety-four, Dillon, Malvina, Bozeman, Regina, Malvina No. 2, Butte (fraction); and the following mill sites: Malvina, Miles, Helena and Glendive.

In the Main Belt are located: the Margaret, Louisa, Balance, Venture, Mary Harrison, Sheridan, Chateau, Dalia, Ely, and Bigelow (unpatented), and the mill sites: Balance, Dalia, and Mary Harrison.

An electric power line runs within ½ mile of the property.

Miners Hope Quartz Mine. Formerly the **Farmers Hope.** First owned by G. L. Kennedy, with several other claims. All went delinquent and the Miners Hope was relocated by Nick Mullins on January 1, 1916. Situated in the Whitlock district, in section 29, T. 4 S., R. 18 E., about 7 miles northwest of Mariposa. Saxon Creek Station on the Yosemite Valley Railroad is about 6 miles northeast by trail. Elevation about 3300 feet, topography mountainous, plenty of timber for mining and plenty of water from springs and from the mine. The vein averages 2½ feet in width, between a mariposite footwall and a porphyry hanging wall, strikes NW. and SE. and dips 85° NE.

Developed by 135-foot shaft, several hundred feet of drifts, and a 385-foot crosscut.

There is a 5-stamp mill, 850-pound stamps, 4′ x 10′ plate, rock crusher, one Frue vanner, 10-h.p. engine, and 12-h.p. boiler. The property has not been worked for several years.

Mocking Bird Quartz Mine. One patented claim owned by J. A. and C. J. Schroeder, of Mariposa. Patented in 1904. This is an extension of the Colorado vein, and is located in section 27, T. 4 S., R. 18 E., in the Colorado district, about 6 miles north of Mariposa. Saxon Creek Station on the Yosemite Valley Railroad is 4 miles north by trail. Elevation 2700 feet, topography rough, timber plentiful, and water enough for mill from springs. There is one vein, averaging 3 feet in width, on the contact between a porphyry footwall and a slate hanging wall. It strikes NW. and SE. and is nearly vertical. The ore is free-milling quartz. A talc-porphyry dike intersects the vein and seems to take the values from the original vein. There is a 100-foot shaft with drifts, and a tunnel several hundred feet long.

The mine was under lease for quite a while to Weston Brothers, who ran several hundred feet of tunnel and took out considerable ore.

Mohawk Mine. Formerly the **North Whitlock Extension,** which was owned by G. L. Kennedy, but was relocated in January, 1916, by Nick Mullins, under the name of Mohawk. Situated in the Whitlock district, in section 29, T. 4 S., R. 18 E., 6 miles northwest of Mariposa and 6 miles southwest of Saxon Creek Station on the Yosemite Valley Railroad. Elevation 3300 feet, topography rough, timber plentiful, and water from springs along Whitlock Creek.

There are two veins, varying from a few inches up to two feet in width, between a porphyry hanging wall and a greenstone footwall. Strike N. and S. and dip almost vertical.

Development consists of a 100-foot shaft with drifts and stopes. There is a Davis hoist, in a corrugated iron building.

Some ore was taken out and milled in the Ducell 5-stamp mill. Not worked recently.

Monte Christo Group. Consists of four unpatented claims owned by F. M. Skelton, Jerseydale, and L. C. Worthington, 1503 G street, Bakersfield, and located in section 20, T. 4 S., R. 20 E., about 4 miles east of Jerseydale.

Elevation 3400 feet, topography rough, timber plentiful, and water from Devil Gulch. Total of 80 acres consisting of Monte Christo, Morning Star, Headlight, and Mazie claims, located in 1913 and 1914.

There are two parallel veins, 600 feet apart, which average 7 feet in width, as far as opened up. They occur on the contact between a porphyry footwall and a granite hanging wall; general strike NW. and SE., and dip about 72° NE. The ore is base, containing some arsenic and antimony.

Development consists of a 65-foot incline shaft, a tunnel several hundred feet long, and several trenches.

Equipment consists of a 12-h.p. gas engine, Rix air compressor, and one Wonder power drill. There is also a blacksmith shop, cabin, windlass and bucket. Worked for several months during 1915, but not since. If costs permit the property will be worked in 1920. Ore is said to assay between $16 and $18 per ton.

Mountain Belle Quartz Mine. One patented claim owned by J. D. Crichton of San Francisco, and located in section 25, T. 5 S., R. 17 E., in the Guadalupe district 6 miles west of Mariposa, and 14 miles southeast of Bagby on the Yosemite Valley Railroad. Elevation 2200 feet, topography rolling, no timber, and very little water.

There is one vein averaging 3 feet in width between quartz porphyry walls. It strikes NW. and SE. and dips 30° SW.

There is an incline shaft 174 feet deep, with two levels, and about 100 feet of drifts.

Equipment consists of a 5-stamp mill, 4 ft. by 10 ft. plate, one Union concentrator, Blake crusher, 15-h.p. gasoline engine, 10-h.p. hoist, and Cornish pump.

The vein runs onto the Mariposa Grant property at both ends. The ore is said to run about $21 per ton. The mine was under poor management, and nothing has been done since 1908. Equipment still on the property.

Mount Buckingham Group. Consists of eight quartz claims, two mill sites and 169 acres of patented timber land, a total of 339 acres. Located in 1850 by Wm. Buckingham. Now owned by J. L. Diven, of Whitlock, and Mrs. C. A. Morgan. Situated in sections 1, 2, 11 and 12, T. 5 S., R. 19 E., about 12 miles northeast of Mariposa. Elevation 4600 feet, surface very rough, and sugar pine, water from Snow Creek.

There are five veins, called the Vanderbilt, Golden Slipper, Crown Point, Apex, and Sunnyside. They vary from 2 feet to 10 feet in thickness, between a slate hanging wall and a granite footwall. The general strike is NW. and SE., and the dip from 70° to 85° SW.

Development consists of a 500-foot crosscut tunnel, a 250-foot raise and several stopes and winzes.

There was formerly a 10-stamp mill, which was destroyed by fire many years ago. Only equipment consists of mine cars, tools, etc.

This is one of the largest, low-grade properties in the county. The different veins are said to assay from $4 to $15 per ton.

Mount Gaines Mine. Consists of sixteen mining claims, 200 acres of patented land, and 160 acres of mineral rights, owned by G. W. Crotts and Sirona E. Crotts, under the title of the Mount Gaines Gold Mining Company. Situated in section 35, T. 4 S., R. 16 E., 7 miles northeast of Hornitos and 14 miles from Merced Falls on the Yosemite Valley Railroad.

Elevation 1100 feet, surface rolling, no timber, and water from mine and springs. This is a large and well-developed property, but it has not been worked since 1910, in which year it was closed down, as it went into debt, and sold, at a sheriff's sale, to A. R. Mains, who later sold to the present owners. The mine was unwatered in 1917, but no production made.

There is a 20-stamp mill with rock crusher, Challenge feeders and eight concentrators. The plates have been removed. Capacity of mill 85 to 100 tons per day. An electric power line, of the San Joaquin Light and Power Corporation, extends to the mine from Merced Falls. There are several motors, five pumps, machine drills, etc. The compressor and hoist have been removed.

There are many buildings, consisting of a blacksmith shop, storeroom, office, cookhouse, two bunkhouses, assay office, seven cottages, four cabins, and other buildings.

Underground developments are extensive, consisting of an incline shaft 1350 feet deep, with eleven levels and a total of 7840 feet of drifts, also several stopes five feet wide and from 400 ft. to 500 ft. high.

There is one quartz vein, from four feet to thirty feet in width, between a granite footwall and a schist hanging wall. Strike northeast and southwest, dip 30°, southeast. The ore occurs in kidneys and lenses. The shaft was sunk to 1350 feet, considerable distance below the lowest level worked, and it is claimed the vein showed strong all the way. The average value of the ore milled was around $8 per ton and the concentrates ran $150 per ton. Considerable underground development work would have to be done before operations could be resumed, but it is believed the property would justify such work.

M. N. Black, foreman at the Ruth Pierce mine, is caretaker, and manager.

Mount Ophir Quartz Mine. Owned by the Mariposa Commercial and Mining Company, E. H. Benjamin, president, 522 Nevada Bank Building, San Francisco. Located in section 12, T. 5 S., R. 17 E., one mile north of the town of Mount Bullion, and ten miles by wagon road from Bagby. Elevation 1900 feet, surface rough, no timber, and very little water. There is one vein, averaging five feet in width between a serpentine footwall and a slate hanging wall. It strikes northwest and southeast and dips 60° northeast.

Development consists of three adit levels, with a total of 1500 feet of drifts, 360 feet of raises, an 80-foot crosscut, 20-foot winze, and a stope 300 feet high, 200 feet long, and 5 feet wide. No reduction equipment.

The mine was opened in the early fifties, and the ruins of what is said to have been the first mint in California may yet be seen on the property. Fifty-dollar slugs were minted.

The mine was closed by the company in 1900, but considerable work has been done by leasers since then. It has not been operated since 1914.

The average value of the ore mined was about $12 per ton.

The power line from the company's power house at Bagby passes over the property. Frank Maguire of Mount Bullion, superintendent.

Mountain King Mine. Owned by the Mountain King Mining Company, Anthony McMillan, president and managing director, office 244 Kearny street, San Francisco; Arthur Hillier, superintendent at the mine.

Located at Mountain King on the Merced River and the Yosemite Valley Railroad, in section 31, T. 3 S., R. 18 E., 6 miles east of Bagby.

The property consists of 19 quartz claims, patents to which have been recently obtained. It is one of the few mines in Mariposa County which has been in continuous operation during the last several years.

There are 4 veins, which average 5 feet in width between slate walls. General strike NW. and SE., and dip 65° NE.

Underground development is shown on the accompanying sketches, taken from a recent report by A. Hillier, superintendent.

There is a Sullivan compressor 16 x 10 x 14 run by a 100-h.p. Allis Chalmers motor; sawmill run by 15-h.p. motor; electric hoist, with 50-h.p. motor; sampler with 3-h.p. motor; electric pump and air fan in the mine, each run by 5-h.p. motor; blacksmith shop with a No. 4 Leymer drill shapever; and a hoist for raising supplies from the station on the railroad to the mill. A twin-motor, General Electric locomotive, capable of hauling eight 1-ton cars is used to haul the ore from the mine to the mill.

A 2½ "Byron Jackson" 4-stage centrifugal pump is used to pump water for milling from the river to one 8000-gallon and one 15,000-gallon tank.

The mill consists of 30 stamps, run by three 25-h.p. motors; a No. 3 McCully gyratory crusher run by a 15-h.p. motor; a 30-foot belt conveyor which swings on an arc, so as to reach all parts of the ore bin, run by a 5-h.p. motor; and 8 concentrators, 3 Johnson, 3 Union and 2 Fine, 6 in use, run by a 10-h.p. motor. All motors are Allis-Chalmers.

A completely equipped and well-designed hydro-electric power plant is located on the Merced River about one mile below the mine.

Mountain View Quartz Mine. Owned by the Mariposa Commercial and Mining Company, E. H. Benjamin, president, 522 Nevada Bank Building, San Francisco. Located in section 11, T. 5 S., R. 17 E., 2 miles northeast of Mount Bullion and 10 miles by wagon road from Bagby.

Elevation 2155 feet, surface fairly rough, no timber, and very little water, from Norwegian Gulch.

There is one vein, averaging 2½ feet thick between slate walls. Strike northwest and southeast and dip about 60° northeast.

The development consists of two adit levels with over 1000 feet of drifts and crosscuts, also several raises and stopes.

The mine has been worked practically continuously for the last ten years by leasers, the ore being milled in the Princeton mill. The ore is fairly high grade, averaging around $40 per ton. Some of it runs as high as $75 per ton.

Number One Mine. Formerly known as the **Martin Quartz Mine,** owned by the Treasure Gold Mining Company. Located in sections 34 and 35, T. 4 S., R. 16 E., about four miles northeast of Hornitos. One full claim, called the Number One, located about 1875. There is one quartz vein, which will average three feet in width, between a slate footwall and a diabase and porphyry hanging wall. It strikes northwest and southeast and dips 43° southwest.

There is a shaft 360 feet deep with three levels and about 1200 feet of drifts, and several large stopes. Equipment consists of a 10-stamp mill, Challenge feeders, two 4 ft. by 16 ft. plates, rock crusher, three concentrators, one Johnson, one Gates, and one Deister. Also electric hoist, with 20-h.p. motor and 40-h.p., 30-h.p., 5-h.p. and 3-h.p. motors. Several buildings, consisting of assay office, storehouse, bunkhouse, transformer house; and several other small buildings. The mine was operated in 1914 and 1915, but has not been worked since.

Number Five Quartz Mine. Owned by the Number Five Mining Company, J. J. Le Tourneau of Berkeley, president. Consists of two full claims and two half claims, a total of sixty acres. Situated in section 10, T. 5 S., R. 16 E., about 3 miles northeast of Hornitos. Surface rolling, elevation 1400 feet, no timber, and water from springs for milling and domestic use.

There are two quartz veins called the Number Five and the Number Two, varying from seventeen feet to thirty feet in width, between a diorite footwall and a schist hanging wall. The strike is northeast and southwest and the dip 45° northwest. There is a shaft 260 feet deep with three levels, and 110 feet of drifts.

Equipment consists of a Parker Linn ball crusher, and Parker Linn ball pulverizer with amalgamator, two five-foot by ten-foot plates, with several motors. Also electric hoist, Gardner compressor, machine drills, pumps, etc. Electricity furnished by the San Joaquin Light and Power Corporation.

Buildings consist of office, cookhouse, bunkhouse, assay office, and several other small buildings.

The above company took over the property in the middle of 1914, and equipped it, after which it was worked for some time. It has not been in operation recently. (April, 1920.)

Number Nine Quartz Mine. Located in section 10, T. 5 S., R. 16 E., about three miles northeast of Hornitos. Formerly owned by the Mose Rogers Estate, Jas. Peck, manager, Mills Building, San Francisco. The property has been in litigation for some time, a law suit being now (April, 1920) in progress between Jas. Peck, S. Webber Parker, and the Number Nine Gold Mining Company, L. A. Ginaca, president, 213 Rialto Building, San Francisco.

The Number Nine Mining Company had equipment on the ground, ready to be set up, consisting of a new electric hoist, 100-h.p. General Electric motor, Ingersoll Rand compressor, size ten inches by fourteen inches, Joshua Hendy 2-stamp mill. A 2½-h.p. gasoline engine was

running a pump, keeping the mine unwatered. Buildings consist of assay office, compressor house, boarding house, office and dwellings. It is expected that operations will commence as soon as title is settled.

The quartz vein averages five feet in width, between a slate footwall and a schist hanging wall. It strikes north 20° east and dips 45° southeast. It is characterized by massive outcrop, which is prominent for quite a distance on the surface. There is a 300-foot incline shaft.

Oaks and Reese Mine. Owned by New York people and located in Hunter Valley, in section 32, T. 3 S., R. 16 E., 14 miles north of Hornitos.

The mine has not been in operation for many years, but it was at one time a very large producer. From 1868 to 1870, during which time it was being worked, it was credited with a production of about $30,000 per month. A lawsuit over water rights, together with the ending of the rich pocket on which they were working, caused the shutdown.

There was a 28-stamp mill in operation in the early days, but it has long since been removed. Present equipment consists of hoist, head frame, pump and old boiler.

There is an incline shaft 450 feet deep and about 800 feet of drifts.

The shaft was unwatered and retimbered since it was closed down.

The shaft is located at the junction of the main vein or "blue lead," with a cross vein known as the "Potts." The main vein is about four feet wide and the Potts vein about eighteen inches. About 400 feet south of the shaft the Floyd vein joins the main vein. It averages about fifteen inches in width. The main vein strikes northwest and southeast and dips about 80° to the northeast. The hanging wall is chert and the footwall porphyrite.

Very little work has ben done on the main vein, operations being confined to the "Potts" vein.

Both the Potts and Floyd veins are said to be rich, and it is claimed the run of mine ore will average around $10 per ton.

There are several hundred tons of low-grade ore on the dump.

Old Wilcox. (See Wilcox.)

Original Quartz Mine. Owned by the Original Mining and Milling Company, E. C. Kocher, president, Merced; G. M. Egendhoff, manager, J. W. Warford, superintendent at the mine.

Located at Clearing House on the Merced River and the Yosemite Valley Railroad, about 6 miles west of El Portal, section 21, T. 3 S., R. 19 E.

Elevation 1500 feet, surface rough, very little timber, and water from the Merced River.

This is one of the few mines in the county which has been working continuously for the last several years.

There is a 10-stamp mill, with Blake rock crusher, 2 Challenge feeders, two 4-ft. by 16-ft. plates, one Deister Overstram table and one Overstram universal table.

The mill is ordinarily run by electric power generated in the company's power plant, situated a short distance above the mill, but when visited in October, 1919, the water in the river was so low that sufficient

power could not be developed, so that a 25-h.p. Fairbanks-Morse distillate engine, had just been installed to run the mill. This was operating very satisfactorily, running 3 days (continuously 3 shifts per day) on 100 gallons of distillate.

There was not enough power to run the hoist and compressor continuously so that the mill was being run on some fairly good ore (about $5 per ton) which has previously been thrown on the dump. It was estimated that there would be some 400 tons of this ore.

The property consists of four claims, 80 acres, all located in 1908. There is one vein averaging 2 feet in width, which strikes NW. and SE., and dips 75 deg. NE. An interesting fact is that the vein runs from the slate into the granite, crossing the contact without interuption.

Development consists of a 700 foot two compartment shaft with six levels. There are 670 feet of drifts on the first level, 1200 feet on the second level, 1300 feet on the third, and 1250 feet on the fourth, 660 feet on the fifth, and 629 feet on the 650 foot level. One crosscut about 200 feet, and 500 feet of raises, and many stopes. In October, 1919, it was estimated that there was 1700 tons of broken ore in the stopes.

The ore is a dark, free-milling quartz carrying about 2% sulphides. It is said to average around $10 per ton.

There is a 30-h.p. electric hoist and 12-ft. by 18-ft. Ingersoll Rand compressor, with skip, machine drill, etc. Buildings besides the mill, consists of post office, boarding house, superintendent's house, lodging house, several cottages, blacksmith shop, assay office and power house. The flume is 1900 ft. long, 6-⅔ feet wide and 4-⅓ feet high, with a ditch line above it about 1500 feet long. The flume carries 6000 inches of water to a 24-foot head. The power house consists of two under-shot Pelton wheels, one 30″ and one 20″ and a Westinghouse 133-kilowatt 100-h.p. generator. It is planned to move the power house farther down the river, on the opposite (south) side.

Orra Rica (Penon Blanco). Situated in the Coulterville district about three miles north of Coulterville near the northern boundary of the county. Owned by the Orra Rica Mines Company, A. E. Tower, San Francisco.

There are two contact veins, varying from three to six feet in width, between a slate footwall and a diorite hanging wall. Strike north 20° west and dip 65° northeast. The outcrop of the vein, and the workings on the top of a ridge, form a landmark for that part of the country.

Equipment consists of a 20-stamp mill complete, also compressor house, blacksmith shop, etc. Development consists of a tunnel over 2000 feet long, with 900 feet driven on the vein. The mine has not been in operation for the past several years, due to troubles over ownership.

Our Chance. One claim owned by Albert Austin and T. E. Austin, and located in section 29, T. 4 S., R. 18 E., in the Whitlock district, about 7 miles northwest of Mariposa.

This has been worked as a pocket mine for the last few years, the gold being panned out. There is one tunnel 150 feet long, with several drifts and a 70-foot winze. A record tunnel is 75 feet long, with a 60-foot winze. There are two anastras on the property, which were used but little.

The claim was located many years ago, and has changed hands several times.

Pine Tree Quartz Mine. One of the "Grant" properties, owned by the Mariposa Commercial and Mining Company, E. H. Benjamin, president, 522 Nevada Bank Building, San Francisco. Located about three miles north of Bear Valley and three miles southeast of Bagby, in section 9, T. 4 S., R. 17 E. Elevation 2070 feet, surface rough, not much timber, water from Bear Valley. There is one vein which averages ten feet in width, between a slate footwall and a serpentine hanging wall. It strikes northwest and southeast, and dips about 55° northeast.

Developments consist of a tunnel and a 380-foot shaft with about 5000 feet of drifts on 4 levels. Also 133 feet of crosscuts and 700 feet of raises.

The mine has been worked by leasers for the past several years, the ore being treated in the Princeton mill. Messrs Turner, Nail, and Finch have been the leasers, since 1915.

When worked by the company the ore was milled in its 5-stamp mill at Bagby. Electric power from the Bagby power house.

Bibl.: Mineral Resources West of Rocky Mountains, J. Ross Brown, 1867, p. 42.

Potosi Quartz Mine. Owned by A. S. Bigelow and G. M. Hyans of 303 Sears Building, Boston; formerly the Merced Gold Mining Company. Located two miles west of Coulterville in section 4, T. 3 S., R. 16 E., Pleasant Valley, 9 miles northwest on the Yosemite Valley Railroad, is the nearest railway station.

Elevation 1700 feet, surface rough, little timber, and water from the mine.

There is one quartz vein, varying from 1 to 20 feet in thickness, between slate walls. Strike NW. and SE. and dip 49 deg. NE.

The 40-stamp mill in which the ore from the several other mines owned by the company was treated, is located on this claim. Equipment consists of 2 rock crushers, 40 stamps, eight 4-ft. by 16-ft. plates and sixteen 4-foot Union Iron Works vanners. The mill was formerly run by a large steam engine, which is still in place, but the power line of the Pacific Gas and Electric Company, is now on the property. There is a well equipped machine shop, boiler house, with four 60-h.p. boilers, hoist, mine pumps, 8-ton steam locomotive with twelve 3-ton cars.

Assay office, transformer house, change house, cook house, office and several other small buildings.

Underground development consists of a tunnel 2500 feet long on the vein, an incline shaft 350 feet deep, 2 air shafts, crosscuts, raise, and stopes.

The mine was partly unwatered in 1912 by Kennedy and Albeck.

Property has not been worked for many years. (See Introduction, p. 87, and Merced Gold Mining Company.)

Princeton Quartz Mine. Owned by the Mariposa Commercial and Mining Company, E. H. Benjamin, president, 522 Nevada Bank Building, San Francisco. Located at Mount Bullion, in section 18, T. 5 S., R. 18 E. This is the largest and most important of the "Grant"

properties. It was first worked in 1852. Most of the ore taken from the company's mines, by leasers, during the last few years, has been treated in this mill.

Equipment consists of 40 stamps, Challenge feeders, crusher, 8 plates, 56 inches wide, by 20 feet long, and 18 Union concentrating tables. One 150-h.p. compressor, two 150-h.p. motors, one 130-h.p. motor, Snow duplex pump.

There is a machine shop, blacksmith shop, carpenter shop, assay office, saw mill, five 50-h.p. boilers, and several other buildings.

The vein averages 8 feet in width, between slate walls, strikes north 35 deg. west, and dips between 45 deg. and 60 deg. northeast.

There is an incline shaft 1660 feet deep with 8 levels, and a total of 11,418 feet of drifts. The ore has been stoped from the 1200-foot level to the surface.

The mine has not been worked for several years, but is credited with a production of considerable over $1,000,000.

The ore is low grade, averaging around $3.50 per ton. Total cost of operating in 1914 was $2.71 per ton.

Bibl.: Mineral Resources West of Rocky Mountains, by J. Ross Brown, 1867, p. 41.

Prothero Brothers Mine. Consists of eight unpatented claims, owned by Prothero Brothers, J. B. Bullock and W. F. Ingwerson, all of Visalia. Two groups, 4 claims in the upper group, Bonita, Monarch, Dandy and Last Chance; and 4 in the lower group, Big Blue with two extensions, and the Sulphretts. The claims were located about 30 years ago, and the present owners have been working at intervals, for about 5 years.

Situated about 2 miles south of Bootjack in section 3, T. 6 S., R. 19 E., on the east bank of the North Fork of the Chowchilla River.

When visited in October, 1919, the tunnel had been driven 200 feet and the vein was just opened up. Quartz stringers were showing in the granite. The country rock is granite and there is a massive iron "Gossan" outcrop on top of the ridge. The vein is probably on the contact between the granite and the slate which lies to the east.

The general strike of the outcrop on the surface is northwest and southeast and the dip about 40 deg. northeast.

Equipment consists of a 60-h.p. distillate engine and Curtis compressor. No reduction equipment.

The owners intended to have a mill test made when the vein was fully exposed.

Quail Mine (Mammoth or Sunset). Consists of seven claims, 138 acres, owned by Brinchi Brothers, of Coulterville, and located in section 16, T. 3 S., R. 17 E., 8 miles southeast of Coulterville, and 9 miles northeast of Bagby on the Yosemite Valley Railroad.

Elevation 2300 feet, surface rough, water from springs, mine, and Indian Gulch. There are 3 veins which average 4 feet in width between a porphyry footwall, and a slate hanging wall, strike northeast and southwest and dip 40 deg. southeast.

Development consists of a tunnel about 1000 feet long, one shaft 150 feet deep, and another shaft 55 feet (incline), several stopes and raises. A 10-stamp mill was destroyed by fire in 1917.

Leased in 1915, for six months to Mr. Cummings, who ran a tunnel, but failed to follow the ledge. Later Mr. Pape exposed the ledge. It was afterwards leased to John Whalen and L. E. McDonald. B. C. Greely had a contract from Whalen and McDonald to drive the tunnel. Development was going on in the latter part of 1919 by M. A. Elftman and a small Gibson mill was in operation.

The value of the ore milled was from $9 to $12 per ton.

There are 200 acres of timber land connected with the property.

Recorder Mine. Consists of one unpatented claim owned by Frank Armstrong and Isaac Miller of Briceburg, and located in section 28, T. 4 S., R. 18 E., in the Colorado district. Worked as a pocket and placer mine.

Elevation 2400 feet, surface rough, plenty of water from springs and from the mines, and some timber.

One quartz vein averaging one foot in width between prophyry walls, strike north and south, and dip about 70 deg. east.

Development consists of one adit level and several hundred feet of drifting.

No equipment, the mine being worked each winter, in a small way, as a pocket and placer mine. Only assessment work done for last two years.

Red Bank Mine. Located on the north bank of the Merced River about two miles northwest of Bagby, in section 26, T. 3 S., R. 16 E. Property consists of several claims, Daisy, Jubilee, Stevenson, and others. Interest held by H. C. Callahan and Percy Petiguer, Crocker Building, San Francisco.

Equipment consists of 25-h.p. General Electric motor and several other smaller motors, tramway across the Merced River.

There is a mill from which the stamps (five) have been removed. Three Wilfley concentrators and a grinding machine remain. Has not been operated for some time.

Country rock is slate, mariposite and serpentine. Two adit tunnels.

Red Cloud Mine. This old mine has not been worked for twenty years. Owned by Mrs. McDiarmid, and located in section 22, T. 2 S., R. 17 E., about 9 miles east of Coulterville. There is one vein varying from one to three feet in width between slate walls. Strike east and west, and dip 60° north. There is an incline shaft 200 feet deep with 500 feet of drifts. There was formerly a 12-stamp mill, but it has been removed. This old mine is said to have a production record of about $1,500,000.

Revel Quartz Mine. One claim owned by Eli Revel and the estate of August Revel. Located at Sweetwater, in section 28, T. 4 S., R. 19 E., 6 miles by trail, south of South Fork siding on the Yosemite Valley Railroad. Several veins averaging 2 feet in width between granite walls, general strike east and west, dip almost vertical. Development consists of a shaft 150 feet deep, with several hundred feet of drifts, and a stope 800 feet long and 150 feet high. No reduction equipment. The mine has not been worked for several years and the workings have caved.

Rittenhoffer. (See Tyro.)

Roma Quartz Mine. One patented claim owned by Matt Harris estate, and located in section 14, T. 4 S., R. 18 E., about 9 miles north of Mariposa. Elevation 2700 feet, surface rough, water from Bear Creek, little timber. One quartz vein, averaging two feet in width, which strikes east and west and dips 60° south. There is a tunnel 1000 feet long. Nothing has been done at the property for about 30 years.

Royal Group. (See Fourteenth Report of the State Mineralogist, page 596.)

Rutherford Quartz Mine. One patented claim owned by A. H. Ward, 53 Stevenson street, San Francisco. Located on the north bank of the Merced River, in section 22, T. 3 S., R. 19 E., 5 miles west of El Portal. The claim was located in the sixty's and patented in 1883.

There is one quartz vein, averaging 4 feet in width, between a slate footwall and a granite hanging wall. Strike about north and south and dip 80° east.

Development consists of a 460-foot adit level, 80-foot raise and a stope 80 feet high and 60 feet long. No equipment. Owner has a mill site on the river. Property has not been worked for 25 years.

Ruth Pierce Quartz Mine (Grimshaw). Located in section 13, T. 5 S., R. 16 E., 4 miles by wagon road east of Hornitos. Owned by the Ruth Pierce Mining Company, subsidiary to the Tennessee Mining Company, M. C. Monday, manager, James A. McMahan, superintendent at the mine, and H. N. Black, foreman.

Formerly known as the Hornitos Gold Mining Company, who took over the property in May, 1916.

There is a completely equipped 10-stamp mill, 1050 pound stamps, Blake crusher, Challenge feeders, two 5 ft. by 16 ft. plates, and 2 Fine vanners. A 30-h.p. motor runs the mill, a 75-h.p. motor operates the compressor, and there is a 25-h.p. electric hoist. Electric power from the San Joaquin Light and Power Company.

There are three quartz veins, averaging 4 feet to 5 feet in width between slate and diorite walls, general strike east and west and dip north 65°. Underground development consists of a shaft 600 feet deep with six levels; 348 feet of drifts on the first level, 639 feet on the second, 600 feet on third, 305 feet on fourth, 1100 on fifth, 800 feet on sixth.

There is a boarding house, superintendent's house and office, bunk house, assay office, etc.

For about the last two years, one shift per day has been working milling 350 to 400 tons per month. The ore averages around $9 per ton. Tailings run $2.50 per ton. Estimated 20,000 tons in tailings pond. Topography rolling, no timber. Two claims on patented agricultural land.

San Domingo Quartz Mine, also formerly known as the **Buffalo,** owned by Wm. Zeller of Oakland. Recently (October, 1919) bonded. Located in section 13, T. 4 S., R. 18 E., in the Colorado district, about 8 miles northeast of Mariposa. Briceburn, on the Yosemite Valley Railroad, is 4½ miles northwest by trail. Elevation about 3000 feet, not much timber, very little water, surface medium rough. One full claim, 20 acres. The vein averages about two feet in width between a slate

footwall and a granite hanging wall, strikes northwest and southeast and dips 50° northeast. The quartz ore is free milling.

Development consists of a 180-foot tunnel and an air shaft 180 feet deep, with several short raises and winzes. Only assessment work has recently been done.

School House Mine. Located on patented agricultural land owned by C. Marchio, in Hunter Valley, in section 10, T. 4 S., R. 16 E., about 12 miles north of Hornitos. By trail to Bagby about 6 miles.

There is a 60-foot incline shaft with some drifting on the vein. There is a two-stamp mill on the property, with concentrator, 8-h.p. gasoline engine, grizzly and crusher; also a hoist with a 20-h.p. engine, two buckets, and a track, built on a trestle, from the mine to the mill about 200 feet.

There is a blacksmith shop, and office building. The mine was worked about three years ago, by Mr. Sutherland of Atwater, Mr. Marchio's son-in-law, but closed on account of disagreement, and has not been operated since. The vein is dark, free milling quartz and lies between porphyry walls.

Schroeder Group. Consists of four quartz claims and one placer claim, total of 100 acres owned by J. A. Schroeder, C. J. Schroeder, P. W. Judkins and C. H. Weston. Situated in the Colorado district, in section 16, T. 4 S., R. 18 E., 2 miles by trail south of Saxon Creek Station on the Yosemite Valley Railroad.

Elevation 2500 feet, surface rough, plenty of water in the winter but little in the summer, and plenty of timber.

There are several veins varying from a few inches to three feet in width between a porphyry footwall and a slate hanging wall, general strike north and south, dip about 80° east. There is also a blanket vein which lies nearly flat, and cuts the other veins.

The property is worked each winter through an open cut, 400 feet long, and 60 feet deep, the material being worked down to the blanket vein. There are also three or four hundred feet of drifts.

Equipment consists of a 5-foot Huntington mill run by a Knight water wheel. There is a boarding house, and a blacksmith shop, also several hundred feet of track.

Sierra Rica Quartz Mine. Consists of two patented claims, the Sierra Rica and King Solomon, 32 acres, owned by M. G. Wilson, and J. M. Graham of San Jose. In section 14, T. 4 S., R. 18 E., 2 miles by trail, south of Briceburg on the Yosemite Valley Railroad. Elevation 2800 feet, surface rough, water from Bear Creek, not much timber. One vein averaging 1½ feet in width, on the contact between a porphyry footwall and a slate hanging wall, strike northeast and southwest, dips 70° southeast.

There is a 300-foot tunnel and a 125-foot raise on the Sierra Rica, and a 100-foot tunnel and a 60-foot raise on the King Solomon. Some drifting.

Equipment consists of a 4-stamp mill, Challenge feeder, rock crusher, and one 4 ft. by 8 ft. plate; blacksmith shop, ore cars, boarding house, dwellings, boiler steam engine, and two miles of ditch.

The property has not been worked to any extent for several years. Three men did some prospecting and drifting in the summer of 1919.

Silver Mine (Bryan Mine). Owned by D. C. McNally of Bootjack, Mariposa County. Under lease and bond to M. L. Crafts, Tevis Crafts, C. Cahen, Geo. Cohn and Mrs. McMeekan, address Elina Hotel, 31 Roma street, San Francisco. Located in section 20, T. 5 S., R. 19 E., about 6 miles by wagon road east of Mariposa, and 2 miles northwest of Bootjack.

Very little water in the summer but plenty in the winter; plenty of oak and pine timber.

Four patented claims, Bryan Nos. 1, 2, 3, and 4. There is one quartz vein material in sugar quartz, not hard, carrying free gold, argentite, tuby silver, and native silver. It will average $5 in gold and 20 oz. of silver to the ton.

Development consists of a 230-foot shaft with two levels; on the 100-foot level, 160-foot drift east and 65 feet west; on the 200-foot level, 60-foot drift east, and 60 foot west.

The present leasers have made a great deal of preparation, and thoroughly sampled the mine, but had made no production up to late in 1919. Shortage of water during the summer, and difficulties in shipment of machinery and material due to the war, held back production.

Equipment consists of a 40-h.p. Union gas engine, 6-foot Marathon mill, 5-foot Huntington mill and two concentrating tables. There is also an old two-stamp mill and a steam hoist on the property.

Silver Lead Quartz Mine. Situated in section 34, T. 4 S., R. 16 E., about 5 miles northeast of Hornitos. Three claims, the Silver Lead with extensions, located in the sixties. W. A. Bradley and associates of Carson City took over the property about March, 1914, and put up a 5-stamp mill, with 850-pound stamps, No. 2 Gates rock crusher, Challenge feeders, 4′ x 16′ plates, two concentrators and 20-h.p. and 10-h.p. motors. Also a compressor, run by a 75-h.p. motor, air hoist, pumps and blacksmith shop. The mine was worked for about three years and then remained idle for two years. In October, 1919, it was being unwatered preparatory to starting operations again.

There is one quartz vein, about one foot in width, between diorite walls; strike northwest and southeast and dip about 42° northeast. There is a 240-foot shaft with two levels, and about 450 feet of drifts. Elevation about 1200 feet, no timber, water from the mine and a spring, surface rolling, electric power from the San Joaquin Light and Power Company.

Spencer Quartz Mine. One patented claim 10.32 acres, owned by Mrs. Jennie Diven of Mariposa. Located in section 29, T. 4 S., R. 18 E., in the Whitlock district, 7 miles northwest of Mariposa, and 6 miles by trail southwest of Briceburg on the Yosemite Valley Railroad. Elevation 2500 feet, surface rough, water from mine and from Whitlock Creek, plenty of timber for mine work.

One quartz vein averaging five feet in thickness, between a diorite footwall and slate hanging wall. Strike northwest and southeast and dip 80° northeast. Development consists of a 150-foot crosscut, 50-foot winze and a stope 350 feet long and 150 feet high. Equipment consists of ore cars, 720 feet of track, hand pump, blacksmith shop and cabin. No operation for the last several years. Work would be commenced if costs were not prohibitive. In the latter part of 1919 costs were as follows: Candles (poor quality) $5.50 per box;

powder 38c to 40c per pound; fuse $1.25 per roll; caps (XXX) $2.50 per box; coal 3c per pound.

Spread Eagle Quartz Mine. Owned by Nick Mullin of Whitlock, via Mariposa. Two claims, Spread Eagle and Empire, and a fraction, Toll Gate, total of 35 acres. Located at Whitlock in section 32, T. 4 S., R. 18 E., 6 miles northwest of Mariposa. Elevation 2880 feet, surface rough, water from springs, not much timber.

There are several veins, averaging 2 feet in width, between porphyry walls, general strike northwest and southeast and dip 40° northeast.

Development consists of a 210-foot shaft, with 2 levels, and nearly 1000 feet of drifts, on the vein, also a 1000-foot adit level, 200-foot crosscut, with several raises and stopes.

Equipment consists of 3 ore cars, 2 blacksmith shops, drills, and 2000 feet of rails.

The mine was worked to some extent in the latter part of 1918, the ore being milled in the Austin mill, 1¼ miles distant. In October, 1919, the property was under option to a New York company.

Squirrel Mine. (See Bunker Hill.)

Stockton Creek Mine. Owned by the Mariposa Commercial and Mining Company, E. H. Benjamin, president, 522 Nevada Bank Building, San Francisco. Located in section 24, T. 5 S., R. 18 E., 1 mile east of Mariposa.

There are two veins averaging about 2½ feet in width, between diabase walls strike east and west and dip about 45° south.

Development consists of a 135-foot incline shaft, with 2 levels, and 550 feet high. All equipment has been removed. The mine has not been worked for many years. It is an extension of the Mariposa vein. The ore is said to have averaged around $5.50 per ton.

Stud Horse Flat Group. Owned by John P. Carroll of Bagby; home office, 670 Elizabeth street, San Francisco. Three claims, White Oak, Marguerite, and Fairview. Located in section 35, T. 3 S., R. 16 E., 3 miles northwest of Bagby. Elevation 1500 feet, oak and pine timber, water from several springs, topography fairly flat, on a plateau overlooking the Merced River and the country to the southeast.

The main vein lies between a slate footwall and a porphyry and diorite hanging wall, and varies from 3 feet to 9 feet in width, averaging about 4 feet. Its strike is northwest and southeast, and dip 75° southeast.

There is an incline shaft 150 feet deep following the dip of the vein, with about 300 feet of drifts on the vein.

The vein material is white quartz, carrying free gold galena, and sulphides. There are several other prospect shafts and tunnels on the property.

A 3-stamp mill was destroyed by fire in 1907, after about 300 tons of ore had been milled. The machinery for a 5-stamp mill is on the property but has never been erected.

The property was bonded in 1918 to a Los Angeles company, who spent considerable money in building and equipment, before doing any development work. The company ran short of funds before any production was made. A wagon road was built from Hunter Valley

to bring in the machinery, and a 2-mile power line was built to the mine from Kittridge on the Yosemite Valley Railroad.

Equipment consists of a Fairbanks hoist, Sullivan compressor, 35-h.p. motor, 3 power drills, blacksmith shop, etc. In the latter part of 1919 the property was idle, but it was understood that the company was endeavoring to obtain capital with which to proceed.

Sunshine Group. Consists of five quartz claims, Sunnyside, Sunshine, Sunshine No. 2, Rosebud, and Johnny F. Owned by Mrs. Jennie E. Diven of Whitlock, via Mariposa, and 147 Kempton avenue, Oakland. Located in sections 19 and 20, T. 4 S., R. 16 E., 8 miles north of Mariposa.

Elevation 2800 feet, surface rough, water from springs, some timber. Three quartz veins, varying from one to three feet in width, between porphyry footwall and slate hanging wall. Strike northeast and southwest, dip 60° southeast.

Development consists of an incline shaft, 110 feet deep, with drifts 200 feet east and 100 feet west, all on the vein. There is a raise 110 feet to the surface, and a stope 140 feet long and almost to the surface.

Equipment consists of a 2-stamp mill, an old Chilian mill, blacksmith shop, gasoline hoist, 2 skips, mine car, drills, tools, etc.

The mine has not been operated to any extent since 1913. About 300 tons of ore were milled, which plated $12.50 per ton.

Sweetwater Quartz Mine. Located at Sweetwater, in sections 17 and 20, T. 4 S., R. 19 E., about 18 miles by wagon road northeast of Mariposa. Seven claims, Sweetwater, Wallace, Hopkins, Huntington, Crocker, Smith and Gage. Total 140 acres.

This is an old property and has been worked at intervals, for many years. At present (November, 1919) under bond to the Dominican Mining Syndicate, Incorporated, H. L. Schultz, box 88, Coalinga, president, and W. J. Minville, box 64, Coalinga, secretary.

There is a 10-stamp mill, which was (November, 1919) being overhauled, preparatory to beginning operations. Equipment consists of a Blake crusher, Cornish rolls, ten 1250-pound stamps, 2 plates 4′ x 16′, 2 Johnson vanners, 1 Standard and 1 Pindar concentrator; also 1 Giant compressor, 2 boilers, 40-h.p. engine, machine drills, etc.

There is a completely equipped assay office, also boarding house, blacksmith shop, office, bunkhouse, etc.

Development consists of an incline shaft 170 feet deep with a level at 123 feet. Drifts on the vein, 350 feet east and 800 feet west. A crosscut 600 feet long, also several raises, and 4 stopes of various sizes.

The quartz vein occurs, more or less, in lenses, and averages about $2\frac{1}{2}$ feet in width, between granite walls. General strike northwest and southeast and dip 45° southwest. The slate formation lies just to the north and west of the mine.

Elevation 3800 feet, surface rough, plenty of timber, and water is piped 800 feet from the head of Sweetwater Creek.

M. Gamble is in charge at the mine.

Tyro (Rittenhoffer). One claim, the Rittenhoffer, located in sections 9 and 10, T. 3 S., R. 16 E., 2 miles north of Coulterville.

Elevation 2300 feet, surface rough, very little timber or water.

There is one vein averaging 2 feet in width, between slate walls, strike northwest and southeast and dip 60° northeast.

Developed by a 700-foot shaft with 6 levels, and about 1400 feet of drifts, with several raises and stopes.

Equipment consists of an old 10-stamp mill with rock crusher, Challenge feeders, two 4-ft. by 12-ft. plates, 3 Frue vanners; also Cornish pump, steam hoist, 2 boilers, blacksmith shop, caretaker house, and 2 large tanks.

The mine has not been worked for many years. It was partly unwatered in 1911.

Virginia Quartz Mine. Four claims, the Virginia (patented), Belmont, Last Chance, and Ninety-four, owned by the White Gulch Mining Company, J. F. Soule, 112 Market street, president; G. E. Gamble, superintendent at the mine. Located in sections 13 and 14, T. 3 S., R. 16 E., 3 miles south of Coulterville and 8 miles north of Bagby on the Yosemite Valley Railroad. This is one of the few mines in Mariposa County which has been operating continuously for the last several years.

Reduction equipment consists of a 10-stamp mill, 1080-pound stamps, Challenge feeders, Blake rock crusher, 2 plates 4 ft. by 16 ft., 2 concentrators, 3½-foot Hardinge ball mill, and a third plate. The tailings from the 2 concentrators go through the ball mill and then over the third plate. A 25-h.p. motor runs the hoist. Other equipment, 50-h.p. Ingersoll Rand compressor, with 50-h.p. motor, No. 5 Ingersoll drill sharpener, ore cars, tracks, pumps, blacksmith shop, office, boarding house, residences, timbershed, etc.

Development consists of a 1000-foot shaft, with adit level, about 6000 feet of drifts, several thousand feet of crosscuts, 400 feet of raises, also several winzes and many stopes.

The vein varies in width from a mere seam, to several feet, and often occurs in lenses. The footwall is serpentine and the hanging wall diabase. The strike of the vein is a little north of west, and the dip about 65° north.

The ore is free milling quartz with mariposite and sulphides. The average value of all ore milled in 1918 was $17.50 per ton. Total operating cost per ton is around $3.

Washington. One claim, 20 acres, formerly one of the Busch Group, now owned by the Pacific States Syndicate of Los Angeles. Located in the Colorado district, in section 21, T. 4 S., R. 18 E., about 7 miles by wagon road north of Mariposa.

Elevation 3000 feet, surface rough, water from mine and springs. The quartz vein lies between slate walls, and varies in width from about 16 feet at the surface to nine feet at the bottom of the shaft. General strike east and west. There is an old shaft and some underground workings.

The claim was originally located in 1904 by L. F. Busch, later sold to the syndicate named above. In the latter part of 1919 the owners had installed a hoist, pumps, drills and everything ready to start operating, but had made no production.

Washington No. 2. Situated about 4 miles northeast of Hornitos. This is an old property and has not been worked for many years, but it is said to have been a very large producer in the early days, and was

the deepest mine in that part of the country when operated. Formerly belonged to the Mose Roger's estate. There is an incline shaft 1500 feet deep. The quartz vein is said to have been twelve feet wide, between slate walls, strike north and south, dip 65° east.

White Oak and Wilcox. Owned by A. H. Ward, 53 Stevenson street, San Francisco. Located at Jenkins Hill Station on the Yosemite Valley Railroad in section 18, T. 3 S., R. 19 E. Two quartz claims, White Oak and Wilcox, four acres, and one mill site, five acres, on the north bank of the Merced River.

There is one vein averaging two feet in width, between a granite footwall, and a slate hanging wall. Strike north and south and dip about 30° east. Developed by a 450-foot adit level, and several shallow shafts, on the surface. Water from the Merced River and Jenkins Creek, and some oak timber, surface rough. It is said the second mill biult in Mariposa County was on this property. It consisted of 5-stamp with wooden stems, and was swept away by the flood of 1862.

In the latter part of 1919, the property was under option, the tunnels had been cleaned out, new tracks laid, cabin and blacksmith shop built, and it was intended to completely equip and operate the mine.

Whitlock Group. Consists of three patented claims, the Whitlock, Alabama, and Westward, patented in 1897. Owned by Dr. Gallison of Oakland and Lizzie Sain. Situated in the Whitlock district, in section 32, T. 4 S., R. 18 E., 6 miles northwest of Mariposa, and 6 miles by trail south of Saxon Creek Station on the Yosemite Valley Railroad.

The elevation is about 3000 feet, not much timber, enough water to run a 20-stamp mill, surface fairly rough.

There are three quartz veins, averaging four feet in width, between so-called greenstone walls. The general strike is northwest and southeast, and the dip about 70° northeast.

Development consists of a 900-foot shaft with four levels and about 3000 feet of drifts, cross cuts etc., and an 1800-foot drain tunnel. Considerable stoping has been done.

Equipment consists of 20-stamp mill, 1000-pound stamp, rock crusher, Challenge feeders 4′ x 10′ plates, four concentrators; also blacksmith shop and tools, air compressor, three machine drills, hoist, 50-h.p. engine, three boilers, assay office, bunk house, boarding house, carpenter shop and dwellings.

The mine was closed about 1899, as it could not be made to pay, using wood for fuel at $4.25 per cord. It has not been operated since. It is stated that there is plenty of $4 ore in the mine.

PLATINUM.

In December, 1919, platinum was discovered in Devil's Gulch, near the junction of Devil Creek with the south fork of the Merced River. The claims are owned by R. O'Donald and Marcus Shimski, and are located in sections 12 and 1, T. 4 S., R. 19 E., about 5 miles by trail from Jerseydale.

The ledge varies from three to four feet in width between slate (?) walls. The mineralized vein occurs on both sides of this quartz ledge, for a width of a few inches, and the ore is said to assay $90 per ton in platinum and $44 in gold.

The ore is heavy, and carries cobalt, nickel and tin in small quantities.

The discovery shaft is now (February, 1920) down about 40 feet and the width of the vein has increased with depth.

T. A. Clark, 2961 Webster street, San Francisco, also reports a platinum discovery on his claim on Devil's Gulch.

Bibl.: Register of Mines, Mariposa County, State Min. Bur., 1903. Mines and Mineral Resources of Mariposa County, State Min. Bur. 1915. 8th Rept. State Mineralogist, 1887-1888, p. 343; 10th Rept. State Mineralogist, 1890, p. 84; 12th Rept. State Mineralogist, pp. 25, 45, 167. 17th An. Rept. U. S. Geol. Surv. Mineral Resources West of the Rocky Mountains, 1867, J. Ross Brown.

MENDOCINO COUNTY.

Mendocino county lies along the coast extending from Humboldt and Trinity Counties on the north to Sonoma on the south. On the east it is bounded by Tehama, Glenn and Lake counties.

The Franciscan formation occupies about three-fourths the area of the county, covering the entire eastern portion from north to south. Eel River and Russian River are the principal streams which drain the county. The former flows north into Humboldt county and thence to the Pacific and the latter south into Sonoma County and thence west to the Pacific. The Northwestern Pacific Railroad follows in general the valleys of these two streams, which extend through the central portion of the county from north to south. Most of the mineral deposits lie on the eastern side of the railroad. The annual mineral production of the county has usually been small but its resources include asbestos, chromite, coal, copper, graphite, magnesite, manganese, mineral water and platinum.

Most of the deposits have been described in the Fourteenth and earlier reports of the State Mineralogist. Manganese and chrome particularly in Bulletin No. 76 and the occurrence of platinum in Bulletin No. 85. Recent developments and new operations are here given.

CHROMITE.

None of the chrome mines in the county were being worked during the summer of 1920. The Red Mountain Chrome property was reported, however, to have been leased to the Suydam Company of San Francisco, who expected to start operating at an early date.

COAL.

The deposit of coal in this county which outcrops along the Eel River near the mouth of Salt Creek a few miles above Dos Rios has attracted attention for many years. The deposit is on the Flood Ranch and is described in the Tenth, Fourteenth and other reports of the State Mineralogist.

The constantly increasing cost of crude oil has again drawn attention to the coal resources of the state and surface indications point to this deposit as one of considerable possibilities. Preparations were under way in June for a thorough prospecting of the deposit by diamond drilling. A camp had been established and Mr. Val Crockett, who has the contract for drilling, was engaged in building a road to transport the rig to the property. The drill is capable of going to a 3000 foot depth and it is stated that if the property reveals the presence of sufficient quantities, a branch railroad probably operated by electric power will be built from the workings along the middle fork of the Eel River to the railroad at Dos Rios, a distance of about six miles. The haul would be down hill and would make an easy outlet.

COPPER.

Nothing was being done with any of the prospects in the county during the year. Some excellent ore is reported to have been found along the middle fork of Eel River, above Dos Rios, but as there are no trans-

portation facilities in the vicinity, nothing has been done with the property.

GOLD. (See under Platinum.)

GRAPHITE.

John L. McNab Property. There is reported to be a bedded deposit of graphite on property belonging to John L. McNab, et al., in township 13 N., R. 12 W. The nearest town is Hopland. The mineral was discovered by the ranch superintendent in 1903. An Oakland paint firm is said to have offered $160 per ton for the material at the time, but owing to litigation, etc., nothing was ever done with it.

MANGANESE.

None of the manganese properties described in Bulletin No. 76 were operating during the year with the exception of the Independent Manganese Mines.

After a production of about 5000 tons, the **Thomas Manganese Mine** was closed down although there is said to be considerable ore still remaining. Most of the manganese mines have been operated by leasers, whose object was to get the greatest tonnage and best ore out in the shortest time. Naturally little attention was paid to the physical condition of the workings with the result that once operations have ceased, it means an extra expense for a new leaser to put the property in a safe condition for further work so that even where there is known to be considerable ore remaining, it is a question whether the investment required to safely open it up is justified.

The **Wild Devil Manganese Mine** has been leased to Lew and Raymond Thorne. The road to this property is in good condition and some work was being done toward cleaning up preparatory to starting operations. The Suydam Company of San Francisco is expected to take over this lease and carry on operations.

Independent Manganese Mine. This property has made a fairly steady production of good manganese ore from 1916 to date with the exception of 1919, when it was closed down. Since the publication of the report in Bulletin No. 76, the mine has shipped about 1000 tons of ore and some second grade ore is sacked and stored at the property. Production has been handicapped by a shortage of labor and inefficient miners. As at present opened up, under normal conditions, the tonnage could be materially increased. The present lease calls for ore containing not less than 45% manganese and not more than 12% SiO_2. Several carloads have been shipped that assayed 54% Manganese and 6% SiO_2. One car sampled 96% MnO_2.

The mine was first operated in 1916 by W. H. Ochsner and Hugo Fischl, who produced about 200 tons in three months. During the last half of 1916, the Noble Electric Steel Company took out about 600 tons. J. E. Page leased it during the spring of 1917 and mined about 500 tons. The Noble Electric Steel Company again leased it in the fall of 1917 and during 1918 up to the signing of the armistice produced 700 tons. It was idle in 1919 but in April of this year, the A. G. Suydam Company obtained a lease and production has continued since that date. G. H. Busch of Potter Valley is owner and superintendent of operations. A

new ore body was recently discovered above the old glory hole and a drift has been started upon this. The lens is approximately nine feet wide by twenty feet in height. Skid rails have been laid from the mouth of the drift up the partly filled glory hole and the ore car is drawn up by horse and cable. Mining is by hand drilling. The present cost of hauling by sled from the mine to a loading platform where motor trucks take it to the railroad at Willits is $2 per ton. Mining costs are said to have increased about 50% with increased depth. The various workings have exposed a considerable tonnage, all of good grade.

Woodman Station Prospect. This property consists of one claim, the Woodman, having an area of twenty acres. It is situated in section 12, T. 22 N., R 14 W., on rounded hills, and lies at an elevation of about 1000 feet. There is some scrub oak on the property. It is three miles from a wagon road and one-half mile from the railroad. Assessment work only has been done, exposing a lens of manganese ore. The owner expects to open it up this season. It was discovered in 1917. Earl W. Long, owner, Covelo.

Manganese is reported to occur along the north branch of Pieta Creek, one mile above the forks and five miles from Pieta. There has been no production but the deposit is said to be a large one.

MINERAL PAINT.

There is a red rock, thought to be suitable for paint making on the property of Mrs. Effie M. Heughes of Calpella. It is on patented land in section 27, T. 17 N., R. 12 W., formerly a part of the Yorcho Ranch. The total area is 380 acres. There is also reported to be manganese on the property. There is no development. A good road runs to the property, which is 14 miles northeast of Ukiah.

MINERAL WATER.

Vichy Springs. These famous springs are owned by John Rademeyer of Ukiah. They are leased with option to purchase by Frank McClure and Eugene E. Schmitz, Mills Building, San Francisco; Eugene E. Schmitz, manager. There are accommodations for 150 guests in the hotel and cottages. A concrete swimming pool and the baths are both supplied with vichy water.

Ornbaun Springs. These mineral springs are situated in section 7, T. 12 N., R 13 W., at Ornbaun, twenty-two miles northwest of Cloverdale and are owned by J. S. Ornbaun. The resort was leased in October, 1919, by Harry S. Wolverton, of San Francisco and has been open to the public during the past year. There are accomodations for fifty persons in the hotel, cottages and tents. The property is pleasantly situated on the edge of a small valley in the hills which is the source of the Garcia River and Ranchers creek. The latter is a tributary of the Navarro River. Altogether there are more than twenty springs on the place but only one has been improved. This is a cold highly carbonated soda spring. No water is bottled.

Orr's Springs. A. P. Wager and Son, owners. A concrete plunge supplied with hot sulphur water has been installed.

There is a large undeveloped soda spring in Soda Gulch, two miles from Comptche and about five miles from Mendocino City. It is utilized by camping parties.

NATURAL GAS.

Austin Muir has been using natural gas for five years from a well 200 feet deep on his place, three miles east of Willits.

PLATINUM.

Mendocino Mining and Milling Company, Incorporated. This company was organized to develop the platinum deposit near Hopland, whose history and geology is described in Bulletin No. 85. An excellent water supply for mining purposes was obtained by sinking a 12″ well near the eastern side of the property. An artesian flow was struck at a depth of 151 feet, but later the water ceased to flow and a Luitweiler Pumping Engine Company's pump, driven by electric power, was installed. This pump has supplied as much a 180 gallons a minute for five hours without materially lowering the water level, which is sufficient for all needs. Work has progressed during the past year on the mining and reduction plant and operations began in August.

The gold and platinum values are all found in the first three feet of depth, so there is no stripping required. The gold is flaky and light. Osmiridium is present in the ratio of one part platinum to 4.08 parts osmiridium. Two sample lots of thirty tons each averaged $1.81 and $1.88 per yard. Platinum figured at $130 per ounce. In sampling, one row of holes twenty-five feet apart, and one row of holes fifty feet apart, and staggered, were dug. About two cu. ft. of dirt was taken from each hole combined, and added to the dirt from two large holes in the flat on the east. This thirty-ton sample averaged $1.88 per yard in value.

The mining and reduction equipment is designed to handle 350 tons in twenty-four hours. Electric power furnished by the California Telephone and Electric Light Company, of Santa Rosa, is used. A drag line scraper will bring the material to the central hopper, whence it will be conveyed by traveling belt to the mill proper. Tailings will be stacked by another belt conveyor.

The property comprises 257 acres located in sections 21 and 28, T. 13 W., R. 11 W. Home office of company, Napa, California; W. B. MacGregor, president; Wallace Rutherford, secretary; Burton Butler, Oakland, California, manager.

QUICKSILVER.

No active property in the county.

STONE INDUSTRY.

With the exception of a small amount of crushed rock obtained at Caspar, near Fort Bragg, for temporary roadwork, there are no quarries in the county. The metamorphic rocks of Mendocino County are not suitable for road material.

CHARCOAL.

Although not a mineral product, the use of charcoal as a metallurgical fuel adds interest to the plant of the California Charcoal Company, home office, 311 California street, San Francisco. The plant is situated at Redwood Valley on the Northwestern Pacific Railroad.

It was built by the Noble Electric Steel Company, and the charcoal was originally shipped to the Heroult Electric Smelter of that company. The plant was acquired by the California Charcoal Company, who added another kiln, making four in all. It requires three weeks to make a complete cycle of the four kilns charging, burning, cooling and discharging. Madrone, oak, willow, manzanita, pine and alder are used, and one car of charcoal a week is produced. This is shipped to San Francisco at the present time. The company has another plant in Marysville.

MERCED COUNTY.

Merced County, like Stanislaus, which adjoins it to the north, lies almost entirely in the San Joaquin Valley, and the mineral industry has played a very small part in its development and growth. However, like all the other counties of the state, some mineral substances of commercial importance have been noted here, and their output since 1880, as far as it has been recorded by the Bureau, has had a total value of over one and a quarter million dollars. The bulk of this figure is accounted for in the gold production of the dredging operations on the Merced River near Snelling.

ASBESTOS.

For many years the occurrence of asbestos has been known in townships 7 and 8 S., R. 16 E., although no work has ever been done to ascertain whether or not commercial deposits might be developed.

CLAY.

High-grade pottery clay has been reported to exist in the vicinity of Merced Falls on land owned by M. Goldman of Merced. Common clay has been found elsewhere, notably near the town of Merced, where for some years a brick plant was in operation. At the present time this material is not being utilized for any purpose.

COAL.

Coal croppings are said to occur in the foothills on the east side of the county between Bear Creek and the Merced River. As far as is known, no work has been done thereon, and the deposits have not been investigated by the Bureau.

COPPER.

Copper has been found in the southwest corner of the county, but not in sufficient quantities to pay commercially. Details relative to occurrence of this metal may be found in the Fourteenth Report, as well as in Bulletin No. 50, entitled "Copper Resources of California." It has recently been reported that **Mr. George Berg** of Panoche has discovered a deposit 18 miles east of Chowchilla, croppings of which have assayed high in both gold and copper. Eight men were working on the prospect in May, 1920, and Mr. Berg was planning to install a mill at the earliest opportunity.

DIATOMACEOUS EARTH.

It has been recently reported that **J. G. Walker** of South San Francisco, and associates, located a claim in the hills west of Newman, containing what is said to be a good quality of diatomaceous earth. No development work has as yet been undertaken on this property.

GOLD.

Traces of gold can be found in the sands of practically all the streams upon the eastern side of the county. Placer mining was carried on here some years ago, to a considerable extent. There was also at one time some primitive placer mining attempted on the west

side, about 20 miles southwest of Los Banos. The only operations of this character which have been carried on for a good many years have been those of the **Yosemite Gold Dredging and Mining Company** at Snelling, on the Merced River. Description of these operations has been given at length in Bulletin No. 57, entitled "Gold Dredging in California," as well as in Bulletin No. 85, on the subject of "Platinum and Allied Metals." This company ceased operations early in 1919, and it was reported that the ground they had been exploiting is entirely worked out.

MANGANESE.

The manganese deposits located in section 13, T. 13 S., R. 9 E., which are described in detail in Bulletin No. 76, have been idle during the past year.

PETROLEUM.

Merced County has not been overlooked in the wide search for petroleum, which has been carried on in all portions of the state during the past year or more. On March 12, 1920, the Turlock Oil and Gas Company was organized, and in addition to the land in the southern part of Stanislaus County, this company has leased several hundred acres in township 6 S, R. 9 E.

The **Nevada Fresno Oil Company,** organized March 15, 1920, also controls a large acreage in northern Fresno County, and in township 12 S., R. 11 E., Merced County.

MONO COUNTY.

Mono County lies north of Inyo and extends from the summit of the Sierra Nevada on the west to the Nevada state line on the east. The greater portion of the county is a broad table land at an altitude of from 5000 to 7000 feet above sea level. Many of the mountain peaks in the western portion of the county rise to an elevation of 13,000 feet and over. The geology and mineral resources of this region have been described in detail in the Fifteenth Report of the State Mineralogist and in earlier publications of the State Mining Bureau and the U. S. Geological Survey. The following notes were taken during a week's trip made by a Bureau representative in August, 1920, and are only intended to briefly cover the activities along mining lines which were noted at that time.

GOLD AND SILVER.

American Prospecting Club. W. C. Ralston, president, 25 Broad street, New York; Sam D. Foreman, superintendent, Benton, California. This company holds a lease on the Grand Central, Midway, Hudson and Super-Six mining claims owned by W. H. Davis of Benton, including within their boundaries the extension of the Diana-Kerrick vein.

The American Prospecting Club has prospected for about 1000 feet along the outcrop of this vein and have driven a tunnel, which at a distance of about 100 feet, intersected the ore body at a point where it was seven or eight feet wide. The values, principally in silver, are high and the outlook for the success of this venture appears to be encouraging. The portal of the tunnel is 6650 feet above sea level. The vein strikes in a northerly and southerly direction and dips about 50° east. Benton, situated on the California Nevada Railroad, is located about five miles northeast of this property and the connecting roads are in good condition.

Blind Spring Hill Mining Company. Mr. L. S. Brown, president, Springfield, Massachusetts; W. H. Davis, agent, Benton, California. This company owns 26 patented claims on Blind Spring Hill, several of which are being operated by lessees. The company itself was not operating at the time the district was visited.

Borasca Mine. F. L. Young, Keeler, California, lessee; Hal Mickersell, superintendent, Benton, California. Property owned by the Blind Spring Mining Company. This mine was a large producer in the early days and has been described in detail in the State Mineralogist's report of 1888 and in other publications. At the present time four men are employed, prospecting the old workings. A small amount of high grade ore has recently been produced.

Cain Cyanide Plant. J. S. Cain, Bodie, California, owner. This plant is being constructed near the old Standard mine with the idea in view of cyaniding the dumps on that property. A crusher and two sets of rolls, percolating tanks, etc., have been installed and it is planned to commence active operations at an early date.

Charleston Group. Owned by J. P. Hammond and under lease to Orris Nay, Mono Lake, California. Four men are employed, driving a tunnel. Detailed description contained in the Fifteenth Report.

Chemung Mine. (See Masonic Mine Association.)

Comanche Consolidated Mining Company. Chas. A. Palmer, president; W. H. Mullock, secretary, 210 Douglas Building, Los Angeles, California; J. S. Adair, superintendent, Benton, California. Location of property on Blind Spring Hill, Benton mining district. This is another of the famous producers of the Benton district, which have been dormant for many years. The present company is driving a tunnel which is now in 1300 feet, and which, it is believed, will cut the vein at about 1360 feet. It is believed this will give about 300 feet of backs on the ore at a point south of the old shaft, which was not penetrated by the former operators. Five men are employed. Equipment consists of a 50-h.p. Semi-Diesel engine and compressor.

Cook-Kibble Leasing Company, Masonic, California. This company has a lease on the Chemung claim, owned by the Masonic Mines Association (which see), and located about 2½ miles southeast of the town of Masonic. Elevation approximately 8000 feet. The lease includes about 1500 feet along the lode, 300 feet of which has been subleased to H. C. Decker. The ore contains free gold, very finely divided, occurring at irregular intervals through a mineralized zone about twenty feet wide. It strikes northeast and southwest and dips almost vertical. At the time the property was visited operations were being carried on through a 130-foot vertical shaft with working levels at 60, 85 and 130 feet from the surface. The mine contains several hundred feet of drifts and a number of small stopes. Equipment includes a 6-h.p. Western hoist. The ore, which is sorted by hand, is sacked and shipped. Ore assaying less than $100 per ton is left on the dumps for further treatment. Several small shipments are said to have averaged as high as $400 per ton in gold. Two men are employed on the surface and eight underground.

Decker Lease. As mentioned under the previous heading, H. C. Decker, Masonic, California, has leased 300 feet on the Chemung vein from the Cook-Kibbel Leasing Company. This lease has been developed by a 100-foot vertical shaft, which is equipped with a 6-h.p. Western gas engine and hoist and a 3-h.p. engine of similar manufacture which operates a sinking pump. One man employed on the surface and three underground. At the time the property was visited, a station was being cut on the 100-foot level and no crosscutting or drifting had as yet been undertaken.

Diana Development Company. Uri B. Curtis, president, 630 Wesley Roberts Building, Los Angeles; Dan Greenwalt, superintendent, Benton, California. This company has acquired the old Cornucopia, Diana and Kerrick mines, situated on Blind Spring Hill, about three miles west of Benton station, at an elevation of 6750 feet. Detailed description of all these old properties has been published in the State Mineralogist's Report of 1888 and elsewhere. The company has twenty-three claims under bond, which include within their limits several parallel veins, only a few of which have been developed to any extent. The

company plans to drive a long crosscut tunnel, starting on the east side of Blind Spring Hill, which will cut at considerable depth several veins which are known to have produced large amounts of high grade silver ore.

F. M. Jones Mines Company. R. C. Cameron, consulting engineer, Berkeley, California. This property, formerly known as the Charleston mine, is located in the Bodie Mining District, at an elevation of 8500 feet. This mine is said to have been a big producer in the early days, although it has been abandoned for many years. The present company is cleaning out the old workings. Two men employed on the surface and six men underground.

King Mine. John King, Benton, California, owner. This gold mine is located about 12 miles south of Benton and has been developed by a 50-foot shaft and several drifts. It is equipped with a 3-stamp mill. Work has been intermittently carried on by Mr. King for many years and a small production is reported.

Log Cabin Group. H. H. Clark, Calexico, and Luther Brown, Los Angeles, owners; James Simpson, manager, Mono Lake, California. This property includes a vein which strikes north and south, containing free milling gold ore, and has been developed by a 230-foot tunnel. It is equipped with a 2-stamp prospecting mill. Six men employed underground.

Lyford Group. W. H. Davis, Benton, California, owner. This is a group of six claims on the east side of Blind Spring Hill, from which considerable high grade silver ore has been produced in times past. Assessment work only for 1920.

Masonic Mines Association. Chas. T. Davis, secretary, 675 O'Farrell street, San Francisco. This association owns several claims situated about 2½ miles southeast of the town of Masonic, among which are included the Chemung Mine, previously mentioned, under Cook-Kibbell Leasing Company. The property covers about 4500 feet along the length of the Chemung vein, which was discovered in 1918. This vein, or lode, strikes in a northeasterly and southwesterly direction and cuts through a granitic country rock. The association is doing some prospecting on the surface, although the principal mining operations have been carried on by leasers.

Monaldo Mining Company. R. G. Woodin, president, 15 State street, Boston, Massachusetts. This company owns several unpatented claims in the Masonic district, formerly known as the Gold Cycle and State Line mines. Idle in 1920.

Mono Mines Company. Wade Armstrong, manager, Coleville. This property, formerly known as the Golden Gate Mines, is located in Antelope Valley Mining District, section 26, T. 8 N., R. 22 E. It has been described in the Fifteenth Report of the State Mineralogist. Idle in 1920, although the new company is preparing to reopen the old workings.

Nevada Progressive Gold Mining Company. A. G. Anderson, superintendent, Sweetwater, Nevada. This property is located in the Patterson Mining District and has been known at different times as the

Silverado, Columbus, and Sweetwater Consolidated mine. It is developed by two adits, each about 400 feet long, the vertical distance between them being 120 feet. Considerable ore has been blocked out by raises. The property is equipped with a Denver Quartz mill, which has been intermittently operated with indifferent success. In August, 1920, there were two men employed in the mine on the surface, six men underground and one man in the mill.

Powell Leasing Company, Benton, California. This company is operating on the southern extension of the Borasca vein on ground owned by the Blind Spring Hill Mining Company. During the past few months a 300-foot incline shaft has been sunk on the vein, in the first 130 feet of which high grade silver ore to the value of $17,000 was shipped. The mine is equipped with a 15-h.p. gasoline hoist and a 3-h.p. blower engine. One man employed on the surface and four underground.

Silver Reef Mine. J. G. Main, Benton, owner; American Prospecting Club, Sam D. Foreman, manager, Benton, California, lessee. Located in Indian mining district. Property includes seven unpatented claims, within which one vein, striking north and south and dipping 70° northeast, is developed with a 130 foot shaft and several small drifts and stopes. The ore shipped in 1920 is said to have netted the owners about $17,000. Two men employed on the surface and four underground.

Standard Consolidated Mine. J. S. Cain, owner, Bodie, California. This famous mine, located in the Bodie district, which has been described at length in former reports of the Bureau and in various mining journals, remained dormant in 1920, with the exception of a small production, resulting from the efforts of leasers who merely used what is known in the silver mines as "chloriding" methods.

Trueman Lease. Benj. Trueman, Benton, California. This lease includes the Anderson claim, owned by the Diana Development Company, located on Blind Spring Hill. It is reported that Mr. Trueman is taking out high grade silver ore in gratifying amounts. Four men employed.

Wild Rose Mine. American Prospecting Club, lessees; Sam D. Foreman, manager, Benton. Property situated 6 miles southwest of the town of Benton. Principal occurences of ore are in a vein averaging about three feet wide, containing gold, lead and zinc values. Development work consists of two prospect shafts, one 30 feet and one 80 feet in depth, and two adits, each about 100 feet long.

MOLYBDENITE.

J. G. Cannon, Sweetwater, Nevada, is reported to have discovered a deposit of molybdenite about 6 miles from that town, across the California border. Samples inspected showed the ore to be granite, carrying about three-fourths of one percent molybdenite. No development work done.

C. L. Faudre, Masonic, California, owns a claim 10 miles south of Fales Hot Springs, containing an immense quartz ledge, portions of

which are said to carry as high as two to three percent molybdenite. A 40-foot prospect shaft has been sunk in the ore and a 208-foot cross cut tunnel has been started, which has not yet reached the ledge. Property idle in 1920.

SODA.

Messrs. Mattley and Parrott, Mono Lake, post office, have a small plant southeast of Mono Lake in which soda has been produced by evaporating the waters of the lake in iron vats. Operations have been intermittent and on a very small scale.

VOLCANIC ASH.

W. H. Davis, Benton, owns a large deposit of fine-grade light gray volcanic ash, near Benton, which was quarried in blocks and used for building purposes in the early days.

MONTEREY COUNTY.

Monterey County borders the central coast of California and is separated from Santa Cruz to the north by the Pajaro River. It adjoins San Luis Obispo to the south and San Benito, Fresno and Kings Counties on the east. Monterey's mineral resources have been little more than prospected, although within its boundaries lie mineral deposits which are of immense potential value. The geology of a large portion of this section has been mapped and described in Bulletin No. 69, of the State Mining Bureau and complete details relative to mines and mineral deposits may be obtained by reference to the Fourteenth Report of the State Mineralogist.

Mining was not particularly active in 1920, although the following notes taken during a short field trip through Monterey County in August, will give some indication of developments which have taken place since the Fourteenth Report was written.

BARITE.

A. R. Haskins, Hollister, California, shipped some barite during the year from a deposit on Fremont Peak. He holds a lease on this property which is owned by Messrs. J. and H. Bardin, Salinas. This material was hauled by truck to the railroad at San Juan.

COAL.

Some development work was carried on and a small production reported by the Stone Canyon Consolidated Coal Company, whose property is located about eighteen miles northeast of Bradley. Some investigation of undeveloped deposits was also carried on as a result of the recent interest which is being taken in the utilization of coal, owing to the threatened shortage of crude oil and the increasing prices of that fuel.

DOLOMITE.

Large deposits of dolomite have been developed in a belt lying along the base of the foothills about 6 miles east of Salinas. Regular shipments of this material have been made by Mr. H. Bardin, C. Z. Hebert, C. Patton and Robert Porter, all of Salinas and all operating at different points along the dolomite belt.

FELDSPAR.

One of the best known feldspar deposits in the state is owned by J. C. Jens, Glendora, California, and is situated 4 miles east of Chualar, with which town it is connected by a good wagon road. The deposit lies between a contact of limestone and granite. It is a massive orthoclase, varying in width up to 150 feet and can be traced for several thousand feet along the strike. A portion of this deposit has been operated by Geo. W. Elder, 799 Oak street, San Francisco.

A feldspar deposit which has not been prospected and the value of which is as yet undetermined was noted on the property of H. Bardin, Salinas, about 7½ miles east of that town.

MOLYBDENUM.

The **Vancouver Pinnacles Molybdenum Company,** T. E. Silvear, manager, Aptos, California, have been doing some work on a molyb-

denum prospect located on the Westcott Ranch, 8 miles east of Soledad. The mineral occurs in a zone which contains a series of quartz veins in granite, striking in a northerly and southerly direction. The work so far done consists of a 50-foot adit, driven on one of the veins which has an average width of about 32 inches. Samples which have been assayed are said to have run as high as 3% MoS.

SALT.

Monterey Bay Salt Company. D. C. and E. C. Vierra, owners, Moss Landing, California. Salt is extracted from the sea water at this point by solar evaporation. The water is pumped from a small lagoon into the evaporating ponds. The brine from these ponds is pumped into vats and the resulting salt is washed and sacked. Most of the production in the past has been sold to fish packers, but it is said to be of exceptional purity, and the Vierra Brothers are planning to put in machinery to make table salt in the near future. The annual production at the present time amounts to about 4,000 tons.

SAND.

Del Monte Properties Company. C. S. Olmstead, manager, Pacific Grove, California (formerly the Pacific Improvement Company). This company is producing glass sand on a large scale from two beach deposits lying between Pacific Grove and Carmel. The largest operations are carried on at the Sand Hill Plant, three miles west of Pacific Grove, near Asilomar. The material is handled by means of a drag line scraper, and it is then screened, washed and dried. The capacity of the plant is from 6 to 8 carloads per day, and this amount will be increased when various improvements, which are now being installed, are completed.

The second deposit operated by the Del Monte Properties Company is known as the Fan Shell Beach Plant, located on the 17-mile drive, about half way between Pacific Grove and Carmel. The sand at this point is raised into 150 ton bins by using a drag line scraper. It is then transported to the railroad by means of automobile trucks. Other occurrences of pure white sand, suitable for glass making, occur at various points along the beach, both north and south of the town of Monterey. Among these deposits which have been commercially utilized to some extent are a large dune near Carmel, owned by the Carmel Development Company; a smaller deposit adjoining, owned by the Carleton Land Company, of Carmel; and a deposit near Del Monte, which has not been utilized for a good many years, but from which several hundred tons of sand were shipped at one time by the California Glass Insulator Company of Long Beach. In addition to the glass sand above mentioned, an immense tonnage of building sand is annually produced by the E. B. and A. L. Stone Company, of San Francisco, from the sand dunes lying west of Lapis Siding on the Southern Pacific Railroad, along the shore of Monterey Bay.

NAPA COUNTY.

The southern end of Napa County touches San Pablo Bay. On its eastern side, it is bounded by Solano and Yolo counties, on the north by Lake, and on the west by Sonoma County. It is about fifty miles north and south by twenty-six miles in width. Mount St. Helena is in the northwest corner at the junction of Lake and Sonoma counties. The mineral resources of this area include cement, magnesite, mineral water, quicksilver, infusorial earth, limestone, copper, iron, chromite, gold and silver, mineral paint, and stone industry. The Fourteenth Report of the State Mineralogist contains a description and bibliography of the principal properties. More recently Bulletin No. 78 discusses the quicksilver mines, and the chrome and manganese mines are described in detail in Bulletin No. 76. Changes and new material here noted will supplement the above and bring them up to date.

CEMENT.

Standard Portland Cement Corporation. This company has two cement plants, one at Davenport, Santa Cruz County, and one at Napa Junction, Napa County. F. H. Davis is general superintendent of both plants. The Napa Junction plant was shut down in September, 1918, and has not been in operation since.

CHROME.

Graves Ranch Mine, located 8 miles northwest of Monticello, is said to have produced about 900 tons in 1918. The ore was shipped to the Sawyer Tanning Company, Napa.

The only mine active during the present year was the Astute Chrome mine. This deposit was discovered in July, 1918, and is owned by Young Adams and W. D. Hayes of Middletown; Young Adams, superintendent. The property consists of one claim, the Astute, situated in section 32, T. 10 N., R. 5 W., about 12 miles from Middletown along the road to Knoxville, just over the Lake County line.

Stringers in serpentine developed into a lens of good ore from which 200 tons had been shipped by truck to the Sawyer Tanning Company, at Napa up to July of this year. At that time the lens appeared to be pinching out, and it is doubtful if the production will greatly exceed the above figures. Two men were working. The road is good to within one-fourth of a mile of the mine. Ore is sledded to this point and loaded on auto trucks.

A limestone ledge was noted in section 32, near this property, and the ruins of an old lime kiln. A shipment of 18 tons of chrome was made from Calistoga by Raymond Thorne in July. It went to Sawyer Tanning Company, at Napa, but its source was not learned.

GOLD AND SILVER.

Manuel Prospect. Idle.

Palisade Mine. Attention has been drawn to this interesting old property also known as the "Grigsby" silver mine by the giving of a lease and option on 100 acres covering the extension of the veins on the Grigsby to L. A. Thomas of Calistoga. Thomas et al have sunk a new

shaft 40 feet deep from the bottom of which a crosscut, said to be entirely in quartz vein matter, has been run 24 feet, without reaching the hanging wall. The entire 24-foot width is stated to assay $12 per ton. Some excellent looking quartz, carrying silver sulphides, was seen by the writer at the shaft opening. The mine is ideally situated with timber and water on the property, and can be reached in fifteen minutes by automobile from Calistoga. The history of the property fully warrants the work done, and with the present price of silver further development seems entirely justified.

Mount Saint Helena Mine (formerly the **Silverado Mine**, Calistoga), owner Harry Patton, Calistoga. This property consists of five claims and one patented location having a total area of 120 acres. There are three parallel quartz veins carrying a little free gold, but most of the values are in the form of chlorides and sulphides. Antimony is present. The average width of the vein being developed is 6 feet with a maximum width of 25 feet. The strike is north 18° east, and it dips 75°–80°. It has been proven for 1200 feet in length. The lower tunnel exposes the vein at a depth of 397 feet below the outcrop. An open cut has been run along the vein for 200 feet, and it has been drifted on for 187 feet on the lower level. The owner estimates that these workings have blocked out $60,000 worth of ore, or 6000 tons. The mine is equipped with a 20-h.p. gas engine. Rix Compressor, cars, rail, tools, blacksmith shop, etc. Air drills are used in mining. Mining costs are $2.75 per ton. There is no reduction equipment, but the owner expects to put in a reduction plant of 20 to 25 tons daily capacity. Treatment will consist of crushing, roasting and amalgamation. Two cars of ore shipped to the Mountain Copper Company in 1918 are stated to have netted $42 per ton, but the average ore is too low grade to ship. It has to be trucked seven and one-half miles to Calistoga, the nearest railroad point. Some work was done in 1919, but it was idle in 1920, pending erection of a mill.

MANGANESE.

No manganese mining in this county during the past year.

MINERAL PAINT.

The **Carl Browne Paint Mine**, on Benali Mountain, 2 miles south of Calistoga, is now owned by W. R. Teale. The material is white. Some shipments were made to Richmond, where it was used in making porcelain ware, and some was shipped to Oakland for the manufacture of bisque doll heads several years ago, but none has been mined during the present year. There are other exposures of this material in the immediate neighborhood.

No work was done during the year at the property of the California Paint Mineral and Mining Company, owned by Mrs. Ellen M. Knoles.

MINERAL WATER.

Calistoga Hot Springs. This property is now owned by Mrs. Pacheteau. A new $34,000 bathhouse was erected early in 1920, with facilities for giving mud, steam and hot sulphur water baths. Two new geysers, or, more correctly, flowing hot water wells, have been bored and capped for use in the bathhouse. C. W. Nance, manager.

Elms Hot Springs. Owner, C. S. Piver. This resort is in Calistoga. There is one well 202 feet deep which supplies hot sulphur water of a temperature of 169°. The flow formerly rose ten feet, but only reaches seven feet at present. It is pumped for use in the showers. Mud baths are also given. The resort was opened in 1915 and there are accommodations for about sixty persons in rooms and cottages.

G. Musante of Calistoga has a bored well 185 feet deep on his property, in which the water rises eleven feet above the surface. It has a temperature of 212°.

Dr. Alder's Sanitarium. Hot water from wells is used for medicinal purposes at this property in Calistoga.

Myrtledale Hot Springs, formerly Myrtledale Farm. This resort is 1½ miles northwest of Calistoga. R. Roy Leveira, proprietor. The following analysis of the water was made at the University of California:

Total residue	44.7 grains per gallon
Sodium chloride	16.8 grains per gallon
Water of crystallization	3.5 grains per gallon
Silica	19.1 grains per gallon
Magnesium carbonate	2.2 grains per gallon
Borax	Trace
Sulphuretted hydrogen	Trace
Potassium carbonate	Trace
Potassium chloride	Trace
Sodium carbonate	Trace
Organic matter	Negative

Among other well known springs in this county, none of which were visited in 1920, may be mentioned the following: Napa Soda, Napa Vichy, Original White Sulphur, Priests, Lanue, Sequoia, St. Helena, or Walters Springs.

QUICKSILVER.

The stagnation marking the quicksilver mining industry during the past year has been reflected in the conditions found in Napa County during the present year. Of the eighteen or twenty properties described in Bulletin No. 78, the Oak Hill Mine was the only one in operation during the year.

This mine has been working on a reduced scale, pending an improvement in labor conditions, water supply and a better quicksilver market.

A new 50-ton Scott furnace was installed in 1918, containing special condenser arrangements and a drier designed by Mr. Murray Innes. The drier is at the top of the furnace and surplus heat from the fire boxes at the bottom is conducted through two outside chimneys to the upper compartment, where it passes over the ore, drying it before it reaches the furnace proper.

All work in the mine at present is confined to the two lower tunnels, where ore was being developed in three breasts and one raise. Fourteen men were employed. The elevation of these workings is 350 feet and 470 feet, respectively, below the top of the furnace, necessitating hoisting all ore this distance up an incline cable tramway. A 6-h.p. engine is used to draw the ore up. Owing to this requirement and the limited production, the furnace was shut down in March of this year and mine development only was in progress at the time of visit. Even the old

dumps, where concentration was carried on from September, 1917, to April, 1918, are above the present working, and it is stated that the management contemplates moving the entire reduction equipment down to a point below the lowest present workings in order to be able to handle the ore by gravity. Lack of water has stopped all concentration of the old dumps. J. C. Ansel is superintendent.

SACRAMENTO COUNTY.

Sacramento County lies mainly in the central valley of California, extending from the foothills of the Sierra Nevada on the east, down to the Sacramento River on the west. The highest elevation in the county is slightly less than 900 feet at a point southeast of Folsom. No field investigations of the mineral resources of this section were carried on during 1920, although they include clay, suitable for the manufacture of brick; natural gas; gold; crushed rock and granite. The most important of these is gold, which occurs in the gravels along the ancient courses of the American River.

Extensive dredging operations have been carried on in this county for the past twenty years. For details relative to individual mineral deposits and extent of mining operations in this portion of the state, see the Fifteenth Report of the State Mineralogist.

SAN BENITO COUNTY.

San Benito County is made up principally of a long narrow valley, flanked on each side by mountains of the Coast Range. It is bordered on the north by Santa Clara and Santa Cruz counties, on the east by Merced and Fresno, and on the south and west by Monterey. Transportation facilities in this section are limited. The Southern Pacific Railroad operates a branch line from Gilroy to Tres Pinos, via Hollister, the county seat. Automobile stages operate between most of the principal towns.

Owing to pressure of other work, the Bureau was unable to send a field representative to this county in 1920, although very complete data relative to its geography, geology, mines and mineral resources may be obtained by reference to the Fifteenth Report of the State Mineralogist.

Mineral production during the past year, as reported to the Bureau's Statistical Department, consisted of cement, dolomite, magnesite, mineral water, quicksilver and miscellaneous stone. In addition to the above the following substances, of great potential value, are known to exist here: antimony, asphalt, barite, bituminous rock, chromite, clay, coal, copper, diatomaceous earth, gems, gold, gypsum, iron, limestone and manganese.

San Benito County ranks among the oldest and most important quicksilver producing counties in California. It contains the New Idria Mine, which during recent years has been the largest single producer in the state.

Considerable interest has been taken in the search for petroleum in this county during the past few months. An oil geologist of the Bureau has completed a survey of the petroleum possibilities, and the result of his findings will be published in a separate report early in 1921.

SAN FRANCISCO COUNTY.

By E. Huguenin and W. O. Costello.

(Field work in 1919.)

INTRODUCTION.

San Francisco is a consolidated city and county of approximately 46½ square miles in area, occupying the northern end of the peninsula that partly encloses San Francisco Bay. San Mateo County bounds it on the south, and the Pacific Ocean on the west. It was created February 18, 1850.

The city is the most important industrial center on the Pacific Coast, having close to 2000 manufacturing institutions within the city limits, among which may be specially mentioned the Union Iron Works, one of the largest ship building yards in the country.

MINERAL RESOURCES.

San Francisco is essentially a city of hills, comprising mostly the metamorphosed sandstones, shales, and cherts of the Franciscan formation. The geology of the county, as well as of the whole bay region, is fully described in the San Francisco Folio of the U. S. Geological Survey. As is to be expected from the limited area and geological formations, but little can be said about the mineral resources, which are very restricted both as regards variety and economic value. The only mineral industry now pursued is the quarrying of the cherts and metamorphosed sandstones for macadam and concrete uses.

Table of Production of San Francisco County.

Year	Brick		Stone industry	Miscellaneous and unapportioned		
	M	Value	Value	Amount	Mineral	Value
1894			$96,864	20 tons	Limestone	$25
1895			379,696			
1896	5,000	37,500	285,167			
1897	4,500	28,500	86,217			
1898			129,595			
1899			275,654			
1900			58,400			
1901			156,947			
1902	25,800	238,800	156,200			
1903	33,403	294,326	508,460			
1904	39,509	367,911	332,220			
1905	32 585	310,685	114,357			
1906	7,208	68,289	106,250	8,500 tons	Glass sand	10,500
1907	44,578	434,140	97,273	4,000 tons	Asphalt	60,000
1908	41,837	345,155	96,259	1,500 tons	Asphalt	15,000
1909	31,430	221,332	150,382	850 tons	Asphalt	9,800
				Unapportioned 1900-1909		
1910			108,126	1,000 tons	Asphaltum	12,000
1911			119,636			
1912			151,147			
1913			110,551			
1914			119,589			
1915			128,270			
1916			76,437			
1917			107,957			
1918			16,463			
1919			65,541			
Totals	265,850	$2,336,638	$4,233,098			$107,300

Brick	$2,336,638
Stone industry	4,233,098
Miscellaneous and unapportioned	107,300
	$6,677,036

Gold occurs in the black sands along the ocean beach at the mouth of the Laguna del Merced. The black sands are deposited in thin layers interstratified with the barren yellow sand. These deposits have been covered to a depth of several feet by the drifting beach sands. Some attempts were made to mine the black sands many years ago, with varying degrees of success. The richer portions were soon worked out, after which the beach was abandoned.

A number of small gold-bearing veins have been found associated with the metamorphic rocks, but the occurrences were too irregular and limited in extent for commercial exploitation.

Traces of cinnabar were reported found in the hills back of the old Mission Dolores, and more recently in the vicinity of Twin Peaks; however, no workable deposit has been, or is likely, to be discovered.

STONE INDUSTRY.

The metamorphosed sandstone and chert beds within the city have been quarried for many years, the materials being used for macadam and concrete work about the city. Many of the old quarries have been abandoned due to the growth of the city, and most of the crushed rock used is shipped in from the neighboring counties.

Only such quarries as are in actual operation or have been recently worked are herewith noted, the older properties having been described in previous reports of this Bureau.

Bibl.: Reports XII, pp. 389-390; XIII, pp. 625-626. Bull. 38, pp. 320-322.

Crocker Quarry. This quarry, located on Lowell street, several blocks south of Mission street, is owned by Bates and Boreland, 593 Market street, San Francisco, and Oakland Bank of Savings Building, Oakland. It was operated for several years, but was exhausted and abandoned in the latter part of 1917. Most of the machinery was taken to the Mission Quarry, on Geneva street, in which the same company has an interest.

The rock was a hard gray metamorphosed sandstone and was used for macadamizing roads in that vicinity.

Golden Gate Park Quarries. The red chert beds which outcrop prominently in Golden Gate Park were formerly quarried quite extensively for use on the roadways in the park. The rock is thin-bedded and friable and easily broken by pick and shovel. At present no quarrying is done, the rock for the park being obtained from the Morgan Quarry at Twelfth avenue and Rivera street.

Gray Brothers Quarry. This company formerly operated a quarry on Telegraph Hill, Green and Sansome streets, but this has been abandoned for some time and they are at present (June, 1919) operating a large quarry in the Mission district, at the head of Castro street at Thirtieth avenue.

The rock is a dark gray metamorphosed sandstone with lenses of serpentine. It is quarried in a semicircular open cut varying from 100 ft. to 150 ft. high and about 200 feet wide. There is an overburden of two or three feet of soil, which gives some trouble. The rock is loaded into $1\frac{1}{2}$-yard cars and hauled a distance of about 200 feet to the crusher. Five tracks run from the crusher to the face of the

quarry. Three of these are level and the cars are pushed by hand or drawn by a horse. The other two tracks are about thirty feet lower at the quarry face and the cars are drawn by cable up the crusher.

The rock is crushed in a No. 6 Fraser and Challenge gyratory crusher, and is elevated to a revolving screen 12 feet long and 4 feet in diameter. This classifies the rock into No. 2, No. 3 sizes and waste. Occasionally an additional 4-foot length of screen is added, producing a No. 4 size. There is a large dump of waste rock which is not marketed, but which apears to be excellent for walks, etc.

From eighteen to twenty men are employed. The plant does not run continuously, but closes down when the demand for rock ceases. Product is sold mostly to contractors for building and street work. Pete Carney is foreman at the plant. A 48-h.p. motor runs all the plant.

Mission Quarry. This property, comprising seven acres, is on Geneva avenue about 1 mile south of Mission street. The rock is a hard gray metamorphosed sandstone and is utilized for macadam and concrete in street work by the city of San Francisco and the United Railroads. It is quarried in a large open cut whose face is over 100 feet in height. The caving system is employed in quarrying, using a huge charge of powder and blowing down the whole face. The large boulders are broken by "bull-dozing" before being sent out to the crusher. Usually sufficient rock is loosened by one charge to keep the crusher supplied for several months.

The rock is loaded into $1\frac{1}{2}$-yard cars and hauled by one horse a distance of about 150 feet to a No. 6 Gates gyratory crusher, located below the track. The rock is crushed to 2-inch size and is raised by a bucket elevator to the top of the bin, where it goes over a screen 40 inches wide and 18 feet long. The oversize comes back to a No. 4 Gates gyratory crusher, located several feet above the No. 6.

A 50-h.p. motor runs the No. 6 crusher and a 35-h.p. motor operates the No. 4. At present the elevator and screen are run by a 35-h.p. motor, but this is soon to be replaced by one of 50 h.p. Electricity is supplied by the Pacific Gas and Electric Company and the United Railroads.

The bunkers have a total capacity of 1000 yds. There is an extra screen 30 inches wide and 20 feet long not running. From 12 to 17 men are employed almost all the year and the output is from 75 to 100 yards per day. The rock will average about $1\frac{1}{4}$ tons to the yard.

This quarry was formerly operated by the United Railroads, but was sold to the Mission Quarry Company in 1915, and bought by the present owners, Bates, Boreland and Ayers, in 1918. H. Bottarini is foreman at the plant.

The Morgan Quarry, formerly operated by the Morgan Improvement Company, is located at Twelfth avenue and Rivera street. It is now owned and operated by W. A. Clark, 381 Bush street, San Francisco. A fire destroyed most of the crushing plant early in 1919, but it has been rebuilt.

Yerba Buena Island Quarry. A bank of friable buff-colored sandstones and shales is occasionally quarried in an open cut on the east side of the island. The rock is used for macadamizing roads about the island, which is the property of the United States government.

SAN JOAQUIN COUNTY.

San Joaquin County has an area of approximately 926,720 acres, of which almost 800,000 are under cultivation. In spite of this fact several valuable minerals occur here, and the annual production during recent years has averaged between $400,000 and $500,000 in value. The mining activities were not investigated by the Bureau in 1920, but they have been described in detail in the Fourteenth Report of the State Mineralogist and the following notes are presented as a matter of general information.

CLAY PRODUCTS.

Large quantities of brick, pottery and other clay products are manufactured at Carnegie and at plants located on the outskirts of the city of Stockton.

GOLD.

The **American Gold Dredging Company,** with offices in the Sharon Building, San Francisco, continues to be a producer of gold, silver and platinum. Its dredging operations are carried on in the Mokelumne River near the Amador border.

NATURAL GAS.

Natural gas has been a very important factor in the fuel question of the manufacturing industry of San Joaquin County, and together with cheap water transportation to San Francisco Bay, gives the city of Stockton somewhat of an advantage over other valley towns. Most of the natural gas wells of San Joaquin County are located in the vicinity of Stockton. The first gas well was bored in the hope of obtaining artesian water, and when the water was tapped an unexpected flow of gas was encountered. The Central Natural Gas Company and the Western States Gas and Electric Company are developing and marketing this product, and in addition several wells owned by individuals are utilized locally for fuel and light.

MANGANESE.

Deposits of manganese are found at various points in the Livermore Hills, the best known property being the Ladd Mine. At this point the first manganese mined in California was produced in 1867. This property is situated 12 miles southwest of Tracy at Corral Hollow.

Aside from the mineral deposits within the boundaries of San Joaquin County, the entire Mother Lode region, which is one of the richest and most prolific regions in the world, is tributary in a commercial sense to Stockton and, therefore, the activities and prosperity of the mineral industry in that section has an important bearing upon the commercial life of that community.

SAN MATEO COUNTY.

By E. Huguenin and W. O. Castello.

(Field work in 1919.)

INTRODUCTION.

San Mateo County, created April 15, 1856, and comprising 447 square miles, is a peninsula county lying directly south of San Francisco with the ocean to the west and San Francisco Bay to the east; Santa Clara and Santa Cruz Counties adjoin it on the southeast and south, respectively. Its total assessed valuation in 1918 was about $38,000,000.

The principal city is San Mateo, with a population of about 7,000, situated 20 miles south of San Francisco, close to the bay shore. Redwood City, the county seat, with a population of approximately 3,000, is located 9 miles south of the city of San Mateo at the edge of the marshes and has a deep water frontage on a channel which comes into the center of the city. This gives desirable manufacturing sites, and several large factories were established here years ago.

The centers of population follow the line of the Southern Pacific Railroad down the east side of the peninsula to its southern boundary. The county is mostly famous for its development into one of the largest homesites for San Francisco people. This is due to its splendid climate, attractive surroundings, and its proximity to San Francisco. Besides the Southern Pacific Railroad, the United Railroad Company of San Francisco operates an electric line down the peninsula to the city of San Mateo. The newly completed state highway, over which automobile stages are operated, also parallels the railroad, making the county very accessible.

On the west coast the climate is more vigorous, high winds and fogs being very common. This coast is more rugged and consequently less populated; however, the rich soil on the west slope of the mountains extending to the sea is rapidly making it famous as a farming section, especially for garden truck.

TOPOGRAPHY AND GEOLOGY.

San Mateo County is traversed by two distinct mountain groups, both having a general northwest trend and being separated by the Merced Valley, which terminates in Merced Lake, the greater part of which lies in San Francisco County. The northern group, the highest point of which is San Bruno Mountain (elevation 1,315 feet), extends into San Francisco. The southern group is a continuation of the Santa Cruz Mountains and culminates in Montara Mountain, the highest peak being 1,952 feet in elevation.

Quoting from the report of Andrew C. Lawson,[1] "In character of relief these two blocks present an interesting contrast. The surface of the northern block is irregularly hilly and, except in San Bruno Mountain, shows but little linearity in the disposition of its crests and valleys. Its geomorphy is fairly mature, although a characteristic feature of that maturity is a certain ruggedness of profile due to the presence of formations composed of radiolarian chert. The exceptional resistance which these offer to erosion causes the areas they occupy to present a marked

[1]Geology of the San Mateo Quadrangle, U. S. G. S. Folio No. 193.

contrast with adjoining areas composed of sandstone. * * *

"The southern block is marked by notable linearity in its crests and valleys and its geomorphy is in general much less mature than that of the northern block. The most remarkable linear feature is the valley in which lie San Andreas and Crystal Springs lakes, a short segment of the San Andreas rift valley, a feature due to repeated faulting in recent geological times. The trace of the fault of 1906 follows this rift for about 300 miles. The valley is due in part directly to earth movement, but in large measure also to the mashing of the rock in the fault zone and its consequent easy erosion. Northeast of the San Andreas rift lies the equally linear Buriburi Ridge which slopes down to Merced Valley

Photo No. 10. San Pedro Point, San Mateo County, on line of Ocean Shore Railroad. Showing steeply-dipping sedimentary strata. Photo by Walter W. Bradley.

and to the Bay of San Francisco. The slope of the Montara orographic block in the area southwest of the rift valley is dissected by a series of subparallel steep-sided cañons and intervening ridges, which are in large part remnants of the original tilted surface. Viewed in a large way, however, this tilted slope, taken as a whole, from the crest of Montara Mountain to the Bay of San Francisco, presents a broadly terraced aspect. It comprises two terrace levels or steps, one the flat-topped ridge that is elsewhere called the Buriburi Plateau, the general elevation of which is about 700 feet, and the other the Sawyer Plateau, comprising a number of flat-topped ridges that stand at elevations of 1,100 and 1,200 feet.

"The crest of the tilted block known as Montara Mountain is composed of quartz diorite and is somewhat serrate in its longitudinal

profile, its serration being due to its incision by the head water erosion of the high-grade streams on its southwest front. On the precipitous shoulders and ridges of the southwest face of the mountain there are obscure traces of terraces at elevations of 400 and 500 feet. At the base of the mountain front, but separated from it by an alluviated valley, is a low ridge known as Miramontes, terminating in Pillar Point. This ridge is composed of folded late Pliocene strata which rest upon the quartz diorite."

The geology of San Mateo County will not be repeated here, as it has already been fully described, partly in the folio cited in the footnote [1] and partly in the Santa Cruz Folio No. 163, to which the reader is referred.

DRAINAGE AND WATER SUPPLY.

San Mateo Creek is the most important drainage channel in the county. It cuts across the Buriburi Ridge, flowing through a deep gorge northeastward to San Francisco Bay, draining the valley of the San Andreas rift both to the northwest and southeast of its head in Crystal Springs Lake. The creek is dammed at the lake, the latter forming a large reservoir whose waters are used to partly supply San Francisco and a few of the towns along the east side of the peninsula. Pilarcitos Creek, which rises in Pilarcitos Lake, forms the drainage basin for the west slope of Cahill Ridge and the east slope of Montara Mountain. It flows in a general southerly direction, emptying into the ocean at Half Moon Bay. Numerous small perennial streams flow down from the west slopes of Montara Mountain Group to the ocean, affording an ample water supply for that coastal region; the most important of these streams being the San Gregorio, Pescadero and Purisima Creeks.

MINERAL RESOURCES.

By far the most important mineral resource of the county is water. Surface water impounded by dams in stream valleys has been extensively used to supply the peninsula cities and towns. Next in importance are the building materials, crushed rock, sand, and gravel, grouped under the heading stone industry. Then follow in order of the value of their production as shown in the following table: salt, brick, limestone and miscellaneous, which includes asphalt, cement, clay, gems, petroleum and sandstone. In addition to the above minerals, small occurrences of barytes, chromite, gold, silver, and quicksilver are known. The total recorded mineral production from 1895 to 1919 was $4,277,800. The production for 1919 was $241,671, San Mateo County ranking thirty-sixth on the list of California counties.

ASPHALT AND BITUMINOUS ROCK.

Hooper Quarry. There is a small bituminous rock quarry located in section 8, T. 8 S., R. 3 W., about 2 miles north of the county line between San Mateo and Santa Cruz counties. It is owned by John A. Hooper, and some rock was used for private road work.

BRICK AND CLAY.

There is at present no common red brick produced in the county, but only pressed and fire brick.

Table of Mineral Production of San Mateo County.

(1835 to 1919, inclusive.)

	Salt		Brick		Limestone		Stone Industry	Miscellaneous and Unapportioned	Value
	Tons	Value	M	Value	Tons	Value	Value		
1895								5,000 tons Clay	$5,000
1896								1,000 bbls. Petroleum	1,250
								500 bbls. Cement	1,250
1897							$40,000		
1898			1,140	$7,000			70,000		
1899			2,870	24,225			34,000		
1900			225	9,000			7,500		
1901	40	400	500	9,070			6,000	17 tons Asphalt	255
1902	6,500	16,000	200	8,000			301,120	5,000 tons Clay	5,625
1903	7,700	25,000	3,100	77,500			150,000		
1904	12,000	62,500	3,902	56,436			113,866	3,000 bbls. Petroleum	6,060
1905	16,030	67,560	5,902	61,436			75,000		
1906	14,900	44,920	6,613	67,000			111,823		
1907	14,000	56,000	8,078	86,285			2,111		
1908	23,800	60,900	4,491	63,231	37,687	$17,451	89,142		
1909	22,100	95,400	1,346	38,405	120,306	96,245	90,221	Gems	500
1910	26,000	61,750	1,350	37,250	111,382	89,106	88,766		
1911	27,500	55,000	1,350	43,000	93,500	74,800	61,185		
1912	33,000	80,000	1,400	40,500	102,300	66,495	29,587		
1913	28,000	72,250	1,418	44,680	138,544	78,506	18,635	Gems	300
1914	27,500	76,750	950	24,074	153,329	75,941	34,648	81,000 tons Sandstone	34,120
								6,581 bbls. Lime	845
								Gems	200
1915	25,500	63,750	715	19,550			93,391	Gems	100
								Unapport.	1,100
1916	28,540	70,807	986	38,121			25,663	593 tons Clay (pottery)	732
								Gems	85
1917	36,483	114,689					71,668	Gems	150

1918	26,434	144,604					34,164	[2]Other minerals	20,656
1919	30,238	136,190					42,235	[3]Other minerals	15,044
								Other minerals	63,246
Totals	406,235	$1,277,410	46,539	$754,763	757,048	$498,544	$1,590,725		$156,358

Brick	$754,763
Limestone	498,544
Salt	1,277,410
Stone Industry	1,590,725
Miscellaneous and unapportioned	156,358
	$4,277,800

[1]The limestone produced in San Mateo County is used as crushed rock and is included under Stone Industry. Previous to 1915 it was erroneously classified as industrial limestone and tabulated under that heading.

[2]Brick and tile, magnesium chloride and potash.

[3]Magnesium chloride and potash.

Steiger Terra Cotta and Pottery Works. This company was incorporated in 1898 and a plant erected at South San Francisco at the water's edge shortly afterward. A fire destroyed most of the plant in 1917 and it has not been rebuilt. This extensive plant, including yardage, covered over ten acres. Most of the clay used was mined in the company's pits in Amador County. A red shale bank at the works was mined to a small extent for use in the manufacture of pressed brick and sewer pipe.

CHROMITE.

Small bunches of chromite occur in the serpentine areas near Crystal Springs Lake, west of San Mateo. These known occurrences are very limited and of too low grade for present commercial extraction.

GEMS.

"On some of the California beaches are found many interesting pebbles of chalcedony that frequently have the appearance of a partial polish. Among the most notable of these beaches are Crescent City, Pescadero, and Redondo. Pescadero, lying some 25 miles directly west of San Jose, may be reached by a beautiful mountain ride of 25 miles from San Mateo. The pebbles are found in great profusion of different varieties of chalcedony and agate, many of them beautifully marked, others are apparently jasper, and occasionally of fossil coral. Some of them are hollow geodes of chalcedony, inclosing a liquid with a moving bubble, like the "hydrolites" from Uruguay, South America, or from Tampa, Florida, and near Astoria, Oregon. These little sealed flasks, as they might be called, vary from the size of a pea, or less, up to rarely an inch in length, and are much sought after."

H. E. Harper of Santa Clara has devoted some time during the past few years gathering these stones along Pescadero Beach, and cutting them for gems. The commercial production has been small, as the demand is very limited.

GOLD AND SILVER.

Occasional small quartz stringers carrying values in gold have been discovered in San Mateo County, none of which are of sufficient extent or richness to be of economic importance. These stringers occur in the Franciscan rocks and are found in local zones of fracture in the metamorphosed sandstones. Several claims were filed on Black Mountain in the San Bruno Mountain group, just south of the San Francisco County line at Visitacion, and some small development work done. The veins uncovered were too poor for exploitation and the claims were abandoned.

A fairly well defined quartz vein, 30 inches in width, occurs on the ranch of **J. M. Macdonough,** ½ mile southeast of Searsville Lake, striking almost due north and south. It outcrops on the Stanford Estate to the south. The vein, a highly oxidized and iron-stained quartz containing some calcite, is deposited in serpentine in the brecciated zone of the San Andreas fault, between walls of jasper and sandstone. It carries, besides gold, some silver and galena.

In the early seventies a hermit by name of **Dominico Grosse** squatted on the land owned by the Stanford Estate and worked occasionally up to the time of his death (1915) developing the vein by digging some pits and trenches to expose it. He obtained some specimens rich in galena, which led to the circulation of highly colored reports concerning the richness of the vein. Recently examinations of the property at the instigation of the owner proved it to be of no commercial value, as the deposit is local, and geological conditions here are not favorable to ore deposition.

Some samples taken across the 30″ face of the vein exposed in the open cuts gave an average assay value of 0.03 oz. gold, 1.10 oz. silver, 0.8% lead.

An interesting discovery was made on property belonging to the **South San Francisco Land and Improvement Company** by T. V. Barton, in March, 1919.

Two parallel veins, one of which has been developed by a 75′ shaft and appears to average about six feet in width, were found outcropping on the hill behind the new high school on the edge of the town of South San Francisco.

The vein upon which the work is being done carries lead, zinc and silver values, a grab sample from which assayed about 20 ounces in silver. The vein strikes N. 40° W. and dips 60° south.

Three men were employed when the property was visited in June, 1920.

GRANITE.

A rock which has been termed "Montara granite" by Andrew C. Lawson in the Annual Report of the U. S. G. S. XV, 1893-1894, pp. 405-415, has been quarried on the property of W. C. Irwin of Montara, near the head of Montara Creek, being used to a small extent for building stone, curbing and crushed rock at Montara on the Ocean Shore Railroad. This rock has been classed as a quartz-grano-diorite by C. A. Waring of the State Mining Bureau, to whom the writer is indebted for the following analyses:

Montara Quartz-Grano-Diorite.

SiO_2	58.78	58.69
Al_2O_3	18.35	18.29
Fe_2O_3	.93	.90
FeO	5.48	5.48
CaO	5.19	5.23
MgO	1.69	1.64
Na_2O	5.25	5.25
K_2O	2.21	2.21
H_2O	.84	.87
LiO_2	1.01	1.04
P_2O_5	.20	.30
	99.95	99.90

The rock consists principally of coarse crystals of white feldspar and black hornblende. It weathers too rapidly to make a satisfactory building stone.

LIMESTONE.

The few isolated limestone deposits of San Mateo County are neither large nor pure enough to be of commercial value for "industrial" uses, such as the burning of lime for cement, fluxes, etc. Two of these deposits, however, both of which are on the west shore, have been worked for structural uses as road building, concrete work, etc., and are described under the heading "Stone Industry."

PETROLEUM.

There has been a small commercial production of petroleum in a limited area southeast of Purisima. The oil is said to be of high gravity and excellent quality. It was obtained from sandstone beds believed to be intercalated with the Monterey shale a short distance below the base of the Purisima formation.[3] The flow was small and there has been no production for some years.

Bibl.: Rept. X, pp. 586-588. Bull. 19, pp. 154-156; Bull. 69, pp. 468-469. U. S. G. S., Geological Folio No. 163.

QUICKSILVER.

Cinnabar has been found in the serpentinized rocks which are intrusive into the Franciscan group, in the region east of San Mateo. On the property of the San Mateo Development Company, 2 miles east of San Mateo, cinnabar occurs in cherts of the Franciscan group. The occurrences are too limited in extent and the rock of too low a grade to be of economic importance.

SALT.

The production of salt by the solar evaporation of sea water along the marshes bordering San Francisco Bay has been an important industry for many years. Three companies are now operating in San Mateo County.

Greco Salt Company, V. C. Greco, president and manager, Redwood City, California. This company's works are located about 3 miles east of Redwood City at the bay shore. A spur track of the Southern Pacific Railroad runs out to the property, so that the salt may be shipped by rail or water. The bay water is evaporated in a series of large vats, and the crystallized salt washed, crushed and stacked by a portable machine operated by a gasoline engine. It is marketed without further treatment. An average of ten men are employed during the season.

Leslie Salt Refining Company, Louis E. Spear, president; St. John Whitney, secretary; Leslie Whitney, vice president and manager; home office, Flatiron Building, 544 Market street, San Francisco. The plant of this company, located at Leslie one mile south of San Mateo, covers approximately 1850 acres along the marshes. It was established in 1901 and has operated continuously since. The refinery is on the east side of the Southern Pacific Railroad tracks and the salt vats stretch out

[3]Geology of the Santa Cruz Quadrangle, by J. C. Branner, J. F. Newson and Ralph Arnold.

beyond the plant toward the bay. The brine is pumped to large outer vats, where it is concentrated by solar evaporation and the concentrated brine pumped to smaller vats closer to the refinery, where the evaporation is completed to dryness. The crude salt covers the ground in depths varying from six inches to one foot. It is shoveled into a train of 1-ton cars which are hauled by gasoline locomotives over a light portable track to the factory. Here it is dumped into the conveying and washing machinery, which stacks the salt in a large pile adjoining the refinery. This machine, the whole operation of which is controlled by one man, automatically washes the salt and cleanses it of all surface dirt while it is being piled. This salt is used in the curing of hides, fish, etc., and the manufacture of ice cream. In 1910 the vacuum process for refining the salt was installed.

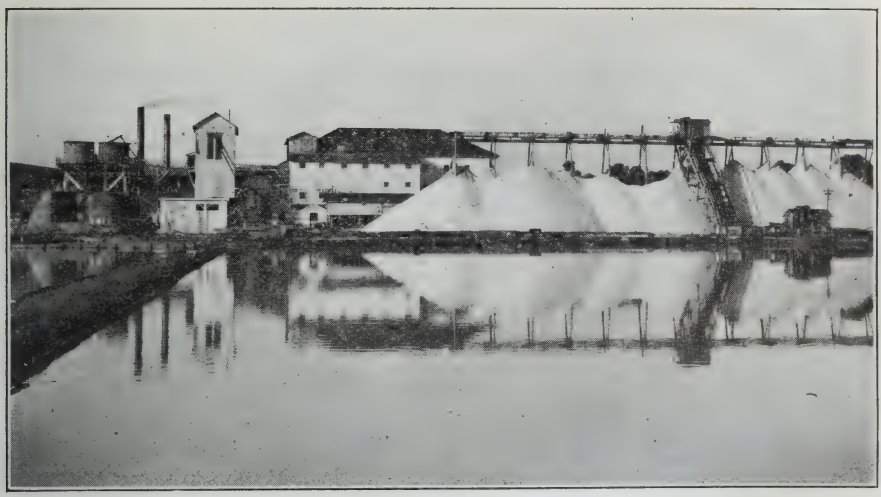

Photo No. 11. Plant of the Leslie Salt Refining Company, showing solar evaporating vats in foreground and storage pile of gathered salt in the background.

The process is briefly described as follows: The crude salt from the storage pile is redissolved in pure fresh water, and the resultant brine is pumped to settling tanks, where it remains for 24 hours. After leaving the settling tanks the brine is put through an intricate system of sterilization and filtration which removes all impurities. It is then pumped into large pans or evaporators, where the water is boiled away and the salt recrystallized in a pure state. Mechanical rakes then carry the salt to the dryers, where all moisture is driven out of it. From the dryer it is conveyed to the screens where it is carefully graded and selected for the various uses. The salt for table and kitchen uses is sacked by automatic weighing and sewing machines operated by girls. Electric power is used to operate the plant, and crude oil for fuel to supply steam for vacuum pans, driers, etc. An average of 100 men and girls are employed producing about 25,000 tons yearly. Mr. Fairbanks is superintendent at the plant.

Whitney Chemical Company, subsidiary to the Leslie Salt Refining Company, now operate a chemical plant in connection with the salt works. Leslie Whitney is president.

The mother liquor from the solar salt vats, at a concentration of about 30° Baume, is pumped to the works where it is evaporated in open pans by steam. There are several products. Magnesium chloride crystals (MgC) is marketed in 200-pound tins under the trade name of "Whitney Special." It is used mostly for making magnesite, for flooring, etc. Magnesium sulphate ($MgSO_4$) is put up in 4-pound cartons, and is used mostly for salt baths. Formerly a 35% potassium chloride (KCl) was produced and sold as a fertilizer, but the market for this having failed it was decided to produce a higher grade prod-

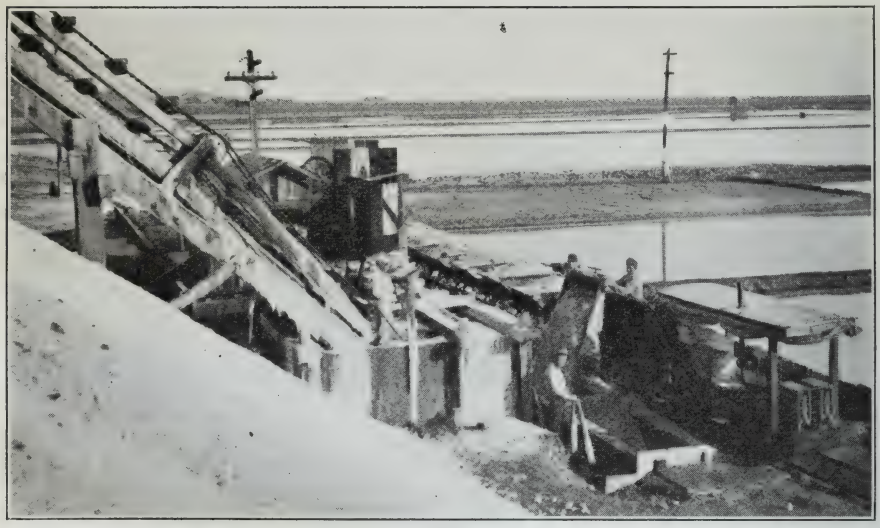

Photo No. 12. Leslie Salt Refining Company, showing a loaded train emptying the salt into bins below the washing and stacking machine. Photo by courtesy of St. John Whitney.

uct. When visited (April 8, 1919) a 97% potassium chloride had just been produced.

No market had at that time been determined for this product. Mr. See is chemist in charge of the plant.

San Francisco Salt Refinery, C. de Guigne, president; C. Jantzen, secretary; home office, 624 California street, San Francisco. This company operates the salt works formerly known as the West Shore Salt Company, on the marshes east of Redwood City adjoining the Greco Salt Company. The property covers 500 acres. The sea water is run into a series of large solar vats and evaporated, and the salt shoveled into wheelbarrows and hauled to a portable washing and stacking machine operated by electric power. This machine is on wheels and can be moved alongside of the different vats. The crude salt is shipped in bulk to the company's refinery in San Francisco, where it is redissolved and recrystallized by a vacuum process very similar to that used at the Leslie Salt Refinery. The capacity of the refinery is 30 tons

daily. Fifteen men are employed at the salt works and the same number at the refinery.

STONE INDUSTRY.

Under this heading are grouped crushed rock and sand. There are many localities in the county in which rock suitable for macadam and concrete work is available. The hard gray metamorphosed sandstone of the Franciscan group is excellent for these uses, and in some localities it has been cut to supply stone for curbing, wall building, etc. Sand is available in great quantities along the many beaches of the west coast.

Byrnes Stone Quarry. Located on Spring Valley Company's property, near the Mountain House on the Crystal Springs road, between San Mateo and Halfmoon Bay. The rock is a blue chert and was used by the county for macadamizing several miles of the road in the vicinity of the Mountain House.

There is another small quarry, about 3 miles south of Crystal Springs Lake. The rock is a red chert and was used by the Spring Valley Company and by the county for road works.

Casey Quarry (formerly the **Laurel Creek Quarry**). Located at Beresford station on Laurel Creek. A deposit of decomposed red chert and buff-colored sandstone was formerly quarried for macadamizing roads in that vicinity. There is no plant at the property. It has been worked at intervals for the past several years. W. W. and J. E. Casey of San Mateo, owners.

Daly's Quarry, operated under lease by the United Railroads of San Francisco, is situated on Daly's Hill at San José avenue $\frac{1}{4}$ mile south of the San Francisco County line. The rock is a close-grained metamorphosed sandstone, light gray in color, and extensively fractured and broken. The present quarry face is about 140′ in height. It is quarried by machine drill and blasting. The broken stone is loaded into 1-cu. yd. cars and hauled by cable over a track to the crushing plant. This is equipped into a ♯5 Gates gyratory crusher, bucket elevator, revolving screens, etc., operated by electric power. The crushed rock is drawn from bins along side of the railroad track and loaded into electric ballast cars. About 20 men are employed and the output averages 80 cu. yds. daily. This quarry has been operated over 15 years by the railroad company, which company uses the entire output. John Murphy is foreman.

Bibl.: Bull. 38, p. 323.

Gardner Quarry, located $\frac{1}{2}$ mile east of Belmont, has been idle for years and was only worked for local road use.

Bibl.: Bull. 38, p. 323.

Pilarcitos Sand Plant, owner, E. B. and A. L. Stone Company, 210 Rialto Building, San Francisco; E. B. Stone, president. The plant, formerly located along side of the Ocean Shore Railroad at Pilarcitos Station on Half Moon Bay, has now been dismantled and abandoned.

A slack line scraper operated by electric power was used to haul the beach sands to the bins along side of the railroad. The plant in operation over six years was forced to shut down during the early part of 1916, due to the increased freight rate granted to the Ocean Shore Railroad by the Railroad Commission.

Rockaway Quarry, under lease to the E. B. and A. L. Stone Company, is located 18 miles south of San Francisco on the Ocean Shore Railroad. The rock is a hard grayish white metamorphosed limestone and occurs in a heavy bed which forms a low hill projecting into the sea. It was quarried by air drilling, blasting, the broken stone being hauled to the crusher below the quarry by a drag-line scraper. Nineteen men were formerly employed but the company has lately ceased operations due to the increase of the freight rate by the railroad

Photo No. 13. Rockaway Quarry, formerly worked by the E. B. and A. L. Stone Company.

company for hauling the stone. The plant has been dismantled and abandoned and the donkeys removed (April, 1919).

San Mateo Development Company, John E. Casey, president and manager; D. J. Stollery, secretary; home office Third and B streets, San Mateo. This company organized in 1907, operates a quarry on the Half Moon Bay road 2 miles west of San Mateo. The rock is the close-grained metamorphosed sandstone, gray in color, characteristic of the Franciscan group. Quarries have been opened at two localities along the road ½ mile apart. The upper quarry is now being worked and the stone is hauled by motor truck to the crushing plant located at the lower quarry, which is not worked due to overlying beds of soft buff-colored sandstone. This plant is equipped with a ♯6 and a ♯4 gyratory crusher, bucket elevators, revolving screens, one 50-h.p. motor and one 30-h.p. motor to operate the plant. The crushed rock is loaded from bins along side of the county road to motor trucks and wagons. It is used for macadamizing rock and for concrete work. Occasionally large blocks are cut for curbing, wall building, etc. An average of 25 men are employed throughout the year.

The **Splivalo and Johnson Quarry** is ½ mile northwest of Belmont. The rock is red chert. It is quarried occasionally for macadamizing roads in that vicinity. There is no crushing plant at the property. Idle.

Bibl.: Bull. 38, p. 323.

The **Vasquez Quarry** is situated 1½ miles southeast of Miramar, a station on the Ocean Shore Railroad. It is operated under lease by John McReynolds of San Jose, a contractor who is doing some work on the State Highway in that vicinity. The rock is an arkose of a light gray color consisting mostly of feldspar and calcite. Locally it is called a limestone. It is crushed in a small plant at the quarry equipped with a #4 gyratory crusher, screens, etc., operated by electric power. Twenty men are employed, the daily output being 100 cu. yds. This quarry has been worked occasionally for the past 10 years. Mrs. Emily Vasquez of Miramar is the owner.

A chemical analysis of this rock made by C. A. Waring is given as follows:

SiO_2	45.78	45.63
Al_2O_3	11.98	12.14
Fe_2O_3	.50	.45
FeO	.10	.05
CaO	21.27	21.29
MgO	1.82	1.87
Na_2O	2.89	3.06
K_2O	1.49	1.35
H_2O	1.40	1.50
TiO_2	.25	.30
P_2O_5	.14	.13
CO_2	13.02	12.96
	100.64	100.73

SANTA CLARA COUNTY.

By E. Huguenin and W. O. Castello.

(Field work in 1919.)

Santa Clara County, created February 18, 1850, lies south of San Francisco Bay and has an area of 1328 square miles. Alameda County bounds it on the north, Stanislaus and Merced on the east, San Benito and Santa Cruz, on the south, and Santa Cruz and San Mateo counties are on the west. Its assessed valuation in 1918 was about $95,000,000.

San Jose, the county seat, is the business center of the fertile Santa Clara Valley. It is 47 miles south of San Francisco on the main line of the Southern Pacific Railroad. The towns of Santa Clara and Palo Alto are next in importance, each having a population of approximately 7000. The former adjoins San Jose to the west and is the seat of the University of Santa Clara, one of the largest Catholic Universities in the west. In the year 1777 the Franciscan Fathers here founded the mission after which the county takes its name. Palo Alto is situated in the northern part of the Santa Clara Valley on the border line of San Mateo County. It lies 28 miles south of San Francisco, and owes its foundation to the establishment there of the Leland Stanford Jr. University, the most richly endowed university in the world. Gilroy, with a population of about 4000, is located near the southern border of the county and is the commercial center of the southern end of the Santa Clara Valley.

TRANSPORTATION.

The coast line of the Southern Pacific Railroad traverses the county throughout its length almost centrally, affording easy access to San Francisco and Oakland. A branch line runs from San Jose, via Los Gatos, to Santa Cruz. The Peninsula Railroad Company operates an electric system between San Jose and Palo Alto, via Los Altos, connecting with Los Gatos and Saratoga, and giving access to several small towns in the northwestern portion of the county. The new State Highway, over which many auto stages are operated, runs parallel to the main line of the railroad. The eastern portion of the county, particularly that mountainous region east of the Mount Hamilton Range, is very inaccessible, being traversed only by a few mountainous roads. That mineralized area in the northeastern portion of the county is at present reached only by road from Livermore. Easier access to this region from the railroad may be gained upon completion of the Patterson and Western Railroad, which is now being constructed. This road follows the Arroyo del Puerto from Patterson into the western border of Stanislaus County, the terminus of which will be not over a few miles from Red Mountain.

TOPOGRAPHY AND GEOLOGY.

The chief topographic feature of the county is the great central valley, comprising nearly one-half of the entire county, inclosed by the two parallel mountain chains which are part of the Coast Range Mountains. The westerly group, known as the Santa Cruz Mountains,

separates the Santa Clara Valley from the sea, and is a series of abrupt ridges whose peaks range in elevation from 2000 to 3000 feet. It is in general well timbered with oak, pine and redwood. The easterly group, which separates the smaller valley from the San Joaquin Valley, consists of several parallel ridges, between which are located small but fertile valleys. The highest of these ridges culminates in Mount Hamilton, whose elevation is 4209 feet above sea-level. These ridges contain only a scattered growth of oak, which is also the condition of the main valley.

The oldest geological formation found within the limits of the country is the Franciscan group. Its age has not been positively determined, but it is generally accepted as Jurassic.[1] It comprises the metamorphosed sandstones, cherts, and serpentines, which make up practically the entire eastern mountain group and the low foothills bordering the west side of the valley. A limited area of marine sandstones and shales which have been identified as Cretaceous overlies the Franciscan group southeast of San Jose. In the western part of the county, the Franciscan formation is overlain by heavy bedded sandstones of the Miocene, which produces the comparatively rugged topography of the bold ridge which separates Santa Clara and Santa Cruz counties. The quaternary formation is represented by the unconsolidated sands, gravels and clays (detritus of the older formations) which fill the valley bottom. Very few eruptive rocks are found in the county. Rhyolite occurs in the vicinity of the New Almaden Mine, southeast of San Jose. Its occurrence was first described by Mr. Becker of the United States Geological Survey.[2] A few narrow basalt dykes are exposed along Coyote Creek east of Madrone Station.

DRAINAGE AND WATER SUPPLY.

There are very few important streams in the county. The chief drainage system is that of the Coyote Creek, which rises in the mountains near the eastern boundary in the center of the county and flows southerly until it breaks through one range of hills south of Gilroy Hot Springs; thence northerly to a point about 3 miles east of Madrone Station, whence it cuts through another range of hills and enters the Santa Clara Valley, flowing northwestward to San Francisco Bay. Second in importance is the Los Gatos Creek, which rises in the Santa Cruz Mountains and flows northeastward, joining the Capitancillos or Guadaloupe Creek at San Jose, whence it also flows northward to the bay. The Los Gatos Creek and its tributaries form the main water supply for San Jose and Santa Clara. The northeastern part of the county is drained by the Alameda Creek and its tributaries, which enters the bay below Niles. The Pajaro River and its branches, the Arroyo de las Llegas, the Uvas Creek, and the San Felipe Creek, drain the southern part of the county. The numerous wells sunk throughout the length of the valley supply ample water for local use.

MINERAL RESOURCES.

Santa Clara County, essentially an agricultural county, was for many years the largest producer of quicksilver in the State, but is now second

[1] Andrew C. Lawson, U. S. G. S. Geological Folio No. 193.
[2] Monograph XIII, The Quicksilver Deposits of the Pacific Coast.

to San Benito County. The mining of magnesite is becoming one of the important mineral industries of the county, and during the past few years there has been a great increase in its production. The minerals produced in order of their value are quicksilver; brick; sandstone; crushed rock, sand, and gravel (combined under the head of stone industry); mineral water; petroleum; magnesite; natural gas; and grouped under miscellaneous and unapportioned, asphalt and bituminous rock, chrome, granite, lime and manganese.

ASPHALT AND BITUMINOUS ROCK.

The asphalt and bituminous rock deposits of Santa Clara County have been fully described in previous reports of this bureau from which the following brief description is extracted:

[3]"The bituminous deposits and springs in the southwest corner of Santa Clara County occur in the foothills forming the eastern slope of the Santa Cruz Mountains. They are principally developed upon the Sargent Ranch, about 3 miles from Sargent Station, on the Southern Pacific Railroad. They are more or less distributed over about sixty acres, although the principal outcrop of the bitumen-soaked strata are confined to an area of a few acres, within which most of the tar springs occur. At this point the shales are light in color when not stained with bitumen, and resemble those in the foothills upon the western side of the Santa Cruz Mountains. A tunnel has been run for a short distance in this formation, but is now caved in. The shales are overlaid by sandstone. About 150 feet down the mountain, and distant perhaps half a mile, are several tar springs exuding from a serpentine formation."

There has been a small production from the above deposits, but not in recent years as this natural asphalt could not compete with that produced as a by-product in the oil refineries.

Bibl.: Reports VII, p. 93; VIII, p. 548; X, pp. 607-609; XIII, p. 43.

BRICK.

The **Peterson-Kartschoke Brick Company,** established over 25 years ago, owns and operates a brick yard at Third and Keyes streets, San Jose. The clay is mined at the company's clay bank one mile east of the yard along the east bank of Coyote Creek. The clay bed is 18′ thick and covers many acres. It is mined by steam shovel and hauled by auto trucks to the yard. Capacity of trucks, four cubic yards each. The clay is shoveled into a hopper and conveyed on a belt to a set of rolls that breaks up any lumps, and feeds directly to a Pug Mill for tempering and then to a Monarch soft-mud machine. The bricks are burned in two Hoffman continuous kilns, each of 41,000 capacity. The plant is equipped with a large steam heated drying room in case of inclement weather. Electric power is used to operate the presses. The products are common brick and floor tile. An average of 40 men are employed during 9 months of the year. G. Kartschoke is president and manager; Maynard Wright is secretary.

The **San Jose Brick Company** owns a clay bank and brickyard 1 mile west of San Jose on the Los Gatos branch of the Southern Pacific Railroad. The company was organized in 1884 and the present plant

[3]Report X, pp. 607–608.

erected in 1893. This property covers 50 acres. The clay bed, of unknown depth, is now mined to a depth of 33 feet by steam shovel, which loads directly into cars of 6 yd. capacity, which are hauled to the brick presses over a cable railway, 1040 ft. long. The plant is equipped with four Monarch soft-mud brick presses, capacity 40,000 each daily; two Hoffman type continuous kilns of 40,000 and 30,000 capacity respectively; one 160-h.p. steam engine for operating plant, two 80-h.p. oil burning boilers. The capacity of the plant is 20,000,000 bricks yearly. However, it has not been run at full capacity for several years. About 40 men are employed. Louis Dossee is superintendent at the plant. In August, 1919, the company was being reorganized; A. M. Anthony, auditor.

CHROMITE.

Chromite occurs in small irregular kidneys and seams in serpentine areas of Franciscan rocks in the Red Mountain District in the extreme northeastern part of the county; in the hills above Alum Rock Park; and in the district 8 miles southeast of Los Gatos. The occurrences are rather limited and the ore is generally too thinly disseminated, or too low-grade to be of commercial value. It is stated that some ore was shipped from the district southeast of Los Gatos over thirty years ago.

Kilday Ranch Deposit. Several small lenses of chromite have been developed on this property which lies along the top of a ridge, probably 1000 feet in elevation above Guadalupe Cañon and 8 miles southeast of Los Gatos. The ridge here is capped with a decomposed serpentine, and chromite has been found at several different places, but thus far no large deposit has been uncovered, and there is very little ore now exposed. About eighty tons of the ore was shipped out by the Farish Company, Insurance Exchange Building, San Francisco, during 1916, but no work has been done since. M. J. Kilday of Los Gatos is the owner.

Laurel Lake Ranch Deposit. J. A. Ferbrache of Gilroy developed a deposit of high grade black chromite on his property 7 miles northwest of Gilroy. The serpentine in which the chrome ore occurs outcrops prominently along the ridge south of Uvas Creek. Associated with the serpentine is a peridotite, thin sections of which have been examined microscopically and show phases high in olivine, and also approaching augite piorite. Although still retaining its original outlines, much of the olivine is seen to be altered to serpentine. One large boulder was uncovered in the loose soil capping and a tunnel is being driven to cut some leaders which occur in the serpentine above. There have been some shipments since the property was visited.

Winship Properties. K. D. Winship, 350 Post street, San Francisco, owner; C. W. Rose and M. J. Gates, lessees, 211 Pacific street, Santa Cruz. Chromite occurs on section 11, T. 6 S., R. 4 E., and on SW. $\frac{1}{4}$ of section 7, T. 6 S., R. 5 E., M. D. M. Holbrook and McGuire, as sublessees in the summer of 1917, shipped several carloads of high-grade chromite from this property. In the latter part of 1918 T. S. O'Brien et al., 75 Fremont street, San Francisco, leased section 11, and built a 50-ton concentrating mill.

Several test runs were made during the first part of Feb., 1919, and about 25 tons of concentrates were produced, averaging 50% Cr_2O_3. The mill was closed down after this owing to market conditions. It is claimed that there is several thousand tons of milling ore here, which will run around 10% Cr_2O_3.

CLAY.

Garden City Pottery, H. M. Stammer, president; Gustav Nelson, secretary. The pottery is located at 560 North Sixth street, San Jose, and the company manufactures flower pots and stoneware. The clay from which the flower pots are made is purchased from the city of San Jose and hauled from Coyote Creek, about 1 mile east of the plant, while the clay for the stoneware is obtained from Lincoln, Placer County, and Carbondale, Amador County. The pottery is equipped with four oil burning kilns, two muffle and two down-draft moulds, presses, etc. Fifteen men are employed throughout the year. The plant has been in operation since 1904.

Pacific Coast Pottery and Terra Cotta Company, F. Eberhart, president; E. C. Hamlin, manager and secretary. The plant of this company at Fifth and Kayes streets, adjoins that of the Peterson-Kartschoke Company, to the east, the Southern Pacific Railroad forming the dividing line between the two. This company manufactures sewer pipe and terra cotta, importing most of the clay used from Amador County. The low-grade clay with which the higher-grade material is mixed is hauled from the company's clay bank along Coyote Creek 1 mile east of the yard. The plant is equipped with four down-draft kilns, machine presses, etc. The plant is operated by steam power using crude oil for fuel.

COPPER.

Hooker Creek Mine. Located 7 miles south of Los Gatos and 1 mile from the station of Eva on the main line of the Southern Pacific Railroad. It is near the line between Santa Clara and Santa Cruz counties. This property is owned by H. E. and J. E. Casey and G. W. Stollery of San Mateo, who began development in 1917. There are two tunnels, one about 300 feet, and the second about 185 feet in length. The ore is chalcopyrite, azurite and malachite, and some of it is said to run very high in copper. It also contains some gold and silver values.

No ore has been sold, although some negotiations were made with the Mountain Copper Company.

From three to four men were employed for several months, but it has been closed down since the latter part of 1918, on account of labor and market conditions. Fifteen men are employed throughout the year.

LIMESTONE AND LIME.

Limestone of a good commercial grade occurs at several places in the mountains bordering the west side of the Santa Clara Valley, the most important deposits being those in the vicinity of Black Mountain, and in the range extending southeastward from Los Gatos to the Guadaloupe mine. As early as 1864, kilns were constructed above the Guadaloupe mine, and a large tonnage of the limestone was burned; however, this

property has been idle since the early nineties. Another quarry was opened 2 miles southeast of Los Gatos, from which the limestone was hauled to kilns at Los Gatos. This, too, has not been worked for many years, and no lime is at present produced in the county.

The Black Mountain deposits outcrop over a considerable area. The rock is a very high grade limestone, and as such is suitable for either sugar refining (for which purpose a large tonnage was formerly quarried by the sugar company mentioned below), or for the manufacture of cement. It is fine-grained and hard, varying in color from yellowish-blue to black. The following analysis is of an average sample of the limestone taken by W. W. Bradley of this Bureau from croppings on the southwest flank of the mountain, in SW. $\frac{1}{4}$ of section 13, T. 7 S., R. 3 W., owned by **K. D. Winship,** 354 Pine street, San Francisco.

(Analyst, Sidney A. Tibbetts, Berkeley.)

Silica (SiO_2)	1.56%
Aluminum oxide (Al_2O_3)	0.47%
Iron oxide (Fe_2O_3)	0.22%
Manganese oxide (Mn_3O_4)	0.05%
Phosphoric oxide (P_2O_5)	0.06%
Calcium carbonate ($CaCO_3$)	97.20%
Magnesium carbonate ($MgCO_3$)	0.43%
Total	99.99%

These deposits suffer the disadvantage of being over 9 miles from the railroad, but they are accessible by wagon road. A railroad, however, could easily be built up the cañon of the South Fork of Permanente Creek to the foot of Black Mountain.

Bibl.: Repts. VIII, pp. 543-546; X, p. 619; XII, p. 394; XIII, p 630. Bull. 38, pp. 82-83.

The **Alameda Sugar Company,** with offices at 310 Sansome street, San Francisco, formerly operated a quarry on Black Mountain, 9 miles by road from Mountain View, on the Southern Pacific Railroad. The limestone was hauled to Mountain View and shipped to their sugar factory at Alviso where it was burned into quicklime and used for refining sugar. This quarry has been idle for the past few years.

Bibl.: Bull. 38, p. 82.

Bernal's California Marl Fertilizer Company, Pedro A. Bernal, president and manager; office 404 South Market street, San Jose. This company owns and operates a limestone quarry on the east slope of the Santa Teresa Mountains, 3 miles by road southwest of Edenvale. The limestone bed covers over 100 acres and is about 200 feet thick. It is irregular in character, grading from a fine-grained hard bluish-gray limestone to a calcareous marl, containing an abundance of shells. The analysis of the marl is given as follows:

(Authority, advertising matter.)

Silica	2.50%
Alumina	11.24%
Iron oxide	2.90%
Magnesia	1.55%
Calcium carbonate	80.81%

This marl pulverizes readily, and is said to be an excellent fertilizer, for which use it is quarried. As this material is very soft, it is easily dug out with pick and shovel, only occasional drilling and blasting being necessary. The marl is pulverized in a Williams Patent Crusher and Pulverizer, which has a capacity of 2 tons per hour, and is operated by a small electric motor. This crusher is a very efficient machine as it does not become clogged when the material is slightly moist. The product is sacked at the quarry and hauled by team to Edenvale, from where it is shipped to the consumers. This industry, established in 1915, has a promising future, as the demand for the fertilizer is steadily increasing. Eight men are employed during the dry season.

Photo No. 14. Quarry of Bernal's California Marl Fertilizer Company, nine miles south of San Jose.

A few years ago, several thousand tons of the hard gray crystalline limestone was quarried under lease by the Spreckels Sugar Company, for use at their refinery, but none of this material is at present quarried.

MAGNESITE.

Magnesite deposits occur in many serpentine areas in the eastern part of the county, the largest and best grade deposits thus far uncovered being those at Red Mountain, in the northeastern corner of the county, now being mined by the Standard Magnesite Company and the Western Magnesite Development Company. These deposits have long been known, and many attempts made to develop them, but their great distance from the railroad and the uncertainty of a market delayed their

exploitation; and it is only within the past decade that they have been put upon a producing basis.

A number of outcrops of magnesite occur at irregular intervals in a belt of soft impure serpentine along the low range of hills bordering the east side of the Santa Clara Valley, extending from east of Coyote Station to Gilroy. These outcrops are small and the magnesite is in general less pure than the Red Mountain deposits. It varies in color from white to buff. Pieces of float may be found in many places along that range. Some development work was done in 1916 at several localities, and some very promising prospects were opened. These deposits have the advantage of being within easy access of the railroad.

Bradford Ranch Deposit. Magnesite occurs in small veins in serpentine 4 miles southeast of Edenvale, along the top of an open rolling ridge. There was some production from the property several years ago, and during 1917 it was worked to some extent by Harry McLaughlin of San Jose, who shipped out several car loads. Work ceased in September.

A dump on the hillside above the Bradford ranch house marks the location of the most extensive underground work, now caved. The country rock is light-brown serpentine with many films of magnesite. Besides this caved entry, there is an open cut now partly caved. Above it a 125-ft. tunnel driven S. 30° W. found no ore. Over this is a tunnel with a cross drift or double entry which followed a vein from 2″ to 10″ thick, and it probably produced a few tons of ore, but there is none in sight now. On the east side of the hill near the top, a cut and tunnel 80 feet long found no ore, although there is a suggestion at this face that it may be approaching a deposit. On the southeast side of this hill, at about the same elevation as other developments, there is a cut 40 feet long which leads into a curving tunnel (length unknown) following a nearly vertical vein of magnesite which apparently varies from a few inches to two feet thick. The footwall is a slip fault, and the hanging wall has many magnesite veinlets or fractures in brownish serpentine. Crosscuts from the tunnel disclosed no ore, and a winze in the floor reaches the bottom of the lens at a depth of eight feet. There is practically no ore in sight in the tunnel, but a trench just above appears, however, to show the top of a 5-foot vein. A few tons of second grade ore are on the dump.

Any further production means considerable dead work to undercut the veins in these workings. Herbert S. Bradford of San Jose, is the owner.

Burnett Ranch Deposit. A deposit of magnesite was developed on this ranch several years ago. Now owned by Michael Righetti. Veins and boulders of good quality occur in an impure serpentine near the top of a ridge one-quarter mile north of the Metcalf road, and three miles northeast of Coyote Station. A vein which varied from 4′ to 10′ wide was mined by an open cut 100′ long. A tunnel was driven on this vein 10′ below floor of cut, but it is now caved. About 75′ northwest of this working, a 10′ tunnel shows a lens of white magnesite several feet in diameter and up to one foot thick. There are about ten tons on the dump. A small cut 300′ to the northwest found a little impure magnesite, and 700′ northwest of the original location a cut on a vein striking N. 45° W. and dipping 45° SW., took out a lens 60′ long.

These are now caved and the deposit is worked out. Walter Arnstein has a lease on the mineral rights here, but the property is idle.

Bibl.: U. S. Geol. Surv. Bull. 355, p. 31.

Jackson Ranch Deposit (formerly known as the **Cochrane Ranch Deposit**), is 4½ miles east of Madrone Station, and 1½ miles south of the junction of Coyote and San Filipe creeks. It is reported that some work was done on the deposit in 1897, and that several carloads of magnesite were shipped. During 1916, Harry C. Warwick, Hearst Building, San Francisco, worked it, taking out several hundred tons. The rock, an impure buff-colored magnesite, outcrops near the top of the ridge west of Coyote Creek. The serpentine is decomposed, and numerous boulders of magnesite have been taken in the open cuts. There is no well-defined ledge and the magnesite appears to be deposited as large blocks or boulders. It is said to contain 4% iron, to which it owes its buff color. No estimate of tonnage can be made, but undoubtedly a small output can be kept up indefinitely. Two men are working, using hand drills, picks and shovels. The ore is hauled down the steep hillside to the floor of the cañon in a sled, then shoveled into wagons and hauled by four-horse teams to Madrone. Alfred Jackson, Jr., is the owner.

Bibl.: Rept. XIII, p. 505. Bull. 38, p. 331; Manuscript of Bull. 79, "Magnesite in California."

Pacific Magnesite Company, Russ Building, San Francisco. This company operated on ten claims on Red Mountain adjoining the property of the Western Magnesite Development Company on the south, 33 miles southeast of Livermore. The claims were located in 1915, and some development work done the following year. In 1917 the property was tied up due to litigation over the ownership, and since then it has, by order of the court, reverted to the Western Magnesite Company.

Two tunnels were driven at elevations of about 50 and 100 feet below a large cropping of magnesite near the top of the ridge. The lower tunnel, 400 feet long, cuts the ledge, exposing an ore body of almost pure white magnesite. A gravity tramway 1200 feet long, with a drop of 400 feet, connects the lower tunnel with an ore bin above the road. A 65-h.p. gas engine and Giant air compressor were installed to supply the necessary air for the machine drills.

The Hoff-Price Company, Monadnock Building, San Francisco, had a lease on several claims of the Pacific Magnesite Company, from which they shipped a few carloads of magnesite in the spring of 1917. Work ceased here when that company began operations at the Sampson magnesite mine in San Benito County.

The **Standard Magnesite Company,** for several months during the first part of 1918, operated a magnesite property in the Red Mountain district about 33 miles southeast of Livermore, in section 18, T. 6 S., R. 5 E. Operations were discontinued in September, 1918. The company owns several claims, only one of which has been developed. There are two tunnels, one of which is 200 feet long, and the other about 75 feet. Considerable ore was hauled to Livermore, and shipped in 1918.

An average of 12 men were employed. There is considerable quipment at the property, consisting of an air compressor, drills, track, cars, etc. H. C. Haecke is president; home office 244 California street, San Francisco.

Weber Ranch Deposits. The Bay Cities Water Company, Coyote, California, owner. The deposits are located on an open ridge, about three miles in an air line northeast of Madrone. On the west slope of the hills near the top a deposit was developed under lease by H. C. Warwick of San Francisco. A large open cut shows a ledge of white to buff-colored magnesite which appears to be quite extensive. Several hundred tons have already been produced from this ore deposit.

On the east slope considerable float has been found and several large cuts were made in the hope of striking the ore in place. The magnesite occurs here in bunch-like or kidney deposits, and it was evidently not deposited in a vein or lode, but as a general alteration of the serpentine with which it is closely associated. As the slopes of the ridge are covered with an adobe soil, and the serpentine very much decomposed, it is impossible to determine without further development work, whether these deposits are in place. The kidneys or boulders are white and evidently quite pure. Several tons had been gathered and were lying on the dump ready for shipment, when visited. A few carloads were shipped by H. Sherlock during 1915 to Berkeley for the manufacture of carbon dioxide, and during 1916 some further development work was done by the owner under the management of H. L. Haehl, Humboldt Bank Building, San Francisco, but the deposits found were too small to warrant exploitation, and work ceased.

Bibl.: Cal. State Min. Bur. Bull. 38, p. 331. U. S. Geol. Surv. Bull. 355, p. 32.

Western Magnesite Development Company, Charles H. Spinks, president, 704 Thomas Clunie Building, San Francisco. This company, organized in 1912, owns and operates the magnesite mine on Red Mountain formerly owned by the American Magnesite Company. During 1917-1918 it was operated by Langdon E. Boyle, 519 California Street, San Francisco, as receiver appointed by the Federal Court on account of litigation between conflicting factions in the company. The property consists of ten claims, four of which are patented, and has been a producer since 1905. It is understood that C. S. Maltby has leased this property for five years and intends to install new machinery and make many improvements. (August, 1919.)

The magnesite outcrops in bold white ledges on the southern and western slopes of the mountain, several hundred feet above the floor of the valley. The following description of these deposits is quoted from the report of Hoyt S. Gale of the United States Geological Survey, who made a thorough study of them.

"The general area containing the magnesite outcrops is occupied by serpentine without evidence of much variation in character or of inclusions of other rocks. The serpentine is bordered on the west by sedimentary sandstones and shales, which form a distinctly different topography. The other limits of the mass of serpentine rock have not been defined. The original country rock from which the serpentine is

Photo No. 15. Open cut of Western Magnesite Development Company. Note lack of outcrop of this large body of magnesite. Ground surface is showing in upper right half of picture. Photo by Walter W. Bradley.

Photo No. 16. Stope in mine of Western Magnesite Development Company, showing magnesite over 30 feet in width. Photo by Walter W. Bradley.

derived is described by Hess as lherzolite and peridotite and is composed essentially of the minerals olivine, diopside, and an orthorhombic pyroxene. The mineral serpentine is a natural alteration product from such rocks. The original country rocks are composed principally of silicates of magnesia (silica, 40 per cent; magnesia, 25 to 40 per cent; alumina and iron variable, usually 5 per cent or more; and a small percentage of alkalies). It is natural to assume that magnesite might be derived by the decomposition or alteration of these silicates being deposited as veins along fissured zones or by replacing the country rock. As a whole, however, the serpentine of this area does not show the

Photo No. 17. Tramway terminal and mine dump of the Western Magnesite Development Company.

excessive amount of shearing to be seen at many of the other magnesite localities.

"Throughout the dark red soil that covers the area of serpentine country rock, especially in the zones that contain the magnesite veins, silica is present in various forms. It occurs, in part, as a white and rosy opal, scattered fragments of which are strewn about on the surface, or it may be observed as chalcedonic veins or coatings in the joints of the country rocks. The silica associated with the purer mass of magnesite in the larger pit is in the form of a pale-greenish granular quartz.

"The magnesite veins are very irregularly distributed and appear to trend in all directions. The larger developed masses are of most unusual size, and even the great bodies that have been removed by mining have been taken out in large open caves or chambers, so as to

give little evidence of the real extent or size of the deposits underground, beyond that which has been taken out."

The principal workings consist of an open cut and several tunnels which have been driven at different levels, exposing a huge ore body, from which many thousand tons have already been mined. The two main tunnels are connected by a large stope or chamber which is over thirty feet in height. The vein at the surface, about 20′ in width, was mined by an open cut over a hundred feet in length. There are numerous other prospect shafts, tunnels, and cuts on the many outcrops, but present work is confined to the main workings. The magnesite is in general very pure; however, towards the border of the large bodies it becomes mixed with the soft serpentinized country rock, having a yellowish color, so that there is no well defined boundary of the magnesite bodies. The high grade ore is said to average 98% magnesium carbonate.

An aerial tramway 2400 feet long connects the main workings with the furnaces, situated in the camp below the mine. The equipment consists of two 10-ft. vertical kilns, two single-burner kilns, steam plant, warehouse, and the usual camp buildings. Crude oil is used for fuel. Sixty to seventy men are employed during nine months of the year, producing about 30 tons per 24 hours. The coarse ore is calcined before shipping, while the fines are shipped without treatment. The ore is hauled 32 miles to Livermore, by auto trucks, the contract price being $4.50 per ton.

Bibl.: Repts. XI, p. 374; XII, p. 328; XIII, p. 505. Bull. 38, pp. 330-331; U. S. G. S. Bull. 540, pp. 498-501.

MANGANESE.

Manganese ores occur in that mountainous region in the extreme northeast corner of the county, bordering Alameda, San Joaquin, and Stanislaus Counties. They occur in the form of oxides in the jasper lenses of the Franciscan formation. This formation, consisting of heavy bedded sandstone, shale and conglomerate, more or less metamorphosed, is intruded by many different igneous rocks. The manganese deposits are very irregular, varying in size from stains and small veins in the chert to comparatively large pockets. The ore varies from soft and powdery to hard and massive. In discussing the origin of these manganese deposits, E. C. Harder writes as follows:

"The manganese ores in the Franciscan jaspers in their present form are clearly secondary concentrations, as is shown by their replacement of jasper and by the intimate association of manganese oxide and quartz veins, suggesting their contemporaneous deposition. That the jasper itself is the source of the ore is shown by the facts that it is invariably associated with the ore deposits throughout the Coast Ranges, and that ores do not occur in the sandstones and shales of the formation."

This theory, however, is now regarded by many as erroneous and the manganese beds are believed to have been deposited with the chert, and to have been altered, in place, from the carbonate of silicate, to the oxide, by the action of water and other agents.

Comparatively little ore was shipped from the different deposits, prior to 1916. The high price of this metal during the war period led

to some renewed activity, but at present none of the properties are being developed.

A huge boulder of manganese lies on Penitencia Creek, just below Alum Rock Park. This boulder labelled "meteorite," was at one time thought to be the outcrop of a large vein. The main ledge from which it came has never been discovered and is probably in that mountainous region at the head of the cañon.

The **Ala Mountain Mine** is 26 miles southeast of Livermore in section 28, T. 5 S, R. 4 E., M. D. M. A vein of manganese ore about four feet wide was exposed by an open cut and a tunnel, and some ore hauled to Livermore several years ago. No work has been done recently. The Merchant Estate of Livermore is the owner.

Black Bear Mine, 25 miles southeast of Livermore, is in section 34, T. 5 S,, R. 4 E., near the summit of the west slope of the Arroyo Mocho Valley, at an elevation of 3100 feet. Interbedded lenses of manganese ore occur in the jasper, some of them are 3′ in thickness and fairly extensive. Development consists of several open cuts and tunnels. Idle. D. P. Doak, Rialto Building, San Francisco, is the owner.

Black Bird Prospect is in the center of section 28, T. 6 S., R 5 E., and is owned by the Mineral Products Company. Some small pits were sunk, but no production was made.

The **Black Wonder Properties** comprise the Jones Group in the NW. $\frac{1}{4}$ of NE. $\frac{1}{4}$ of section 27; the Black Wonder in the SE.$\frac{1}{4}$ of SE. $\frac{1}{4}$ of section 27; and the Mexican Prospect, in SW. $\frac{1}{4}$ of SE. $\frac{1}{4}$ of section 27, T. 6 S., R. 5 E., near the Stanislaus County boundary. It was formerly the property of the California Manganese Mining Company, of which Howard A. Broughton was President, and is now owned by the Mineral Products Company, with offices at 334 Rialto Building, San Francisco. This company, organized in 1915, is developing the property in connection with its deposits of chrome in Stanislaus County. A narrow gauge steam railroad, called the "Patterson and Western," was constructed from Patterson 23 miles up the Cañon del Puerto to the foot of Red Mountain, where Camp Jones has been established. Here it connects with a 2-ft. gauge gasoline tramway, five miles in length, which runs to the Jones Mine near the top of the ridge at an elevation of 2750 ft., almost 1000 ft. above the terminus of the Patterson and Western Railroad.

The company erected a factory at Patterson for the manufacture of manganese dioxide from the ores mined at this group.

These manganese deposits are the most important ones thus far discovered in the county, and their occurrence has been described in Harder's report[1] as follows:

"The southern part of the area covered by the claims is greenish-gray sandstone of the Franciscan formation; the northern part is a mixture of jasper and fine shale interbedded. This jasper area is part of a larger area extending in a general east-west direction for 3 or 4 miles between the sandstone on the south and a large area of serpentine on

[1] *Op. cit.*, pp. 162-163.

the north. Where the principal manganese ore deposits occur the jasper-shale belt is about a mile wide. The manganese ores extend as discontinuous deposits along the jasper belt for more than a mile in a general northwest-southeast direction, the principal deposits being to the southeast and very near the sandstone contact.

"The jasper-shale formation consists of beds and lenses of jasper interbedded with fine shale. The jasper may be thin bedded or very heavy bedded, in the last case forming prominent outcrops. The beds generally strike in the direction of the main jasper belt, but the dips are exceedingly irregular.

"The manganese ore occurs along heavy jasper beds as large masses replacing it, as veins, or merely as stains and partial replacements along cracks. The principal deposits, that is, those at the southeast end, are found along two or three prominent jasper beds 300 to 500 yards long, which are nearly parallel and 50 to 200 feet apart, separated by thin bedded jasper and shale. Of these, the deposits in the bed farthest south are most prominent."

Development consists of two tunnels and several open cuts. In both tunnels are exposed ore bodies varying from 5 to 8 feet. The ore is bluish black and more or less mixed with the country rock. Occasional pockets of soft and powdery ore of high grade occur in the ore body.

At the time visited, October, 1916, no development work was being done at this group, but it was expected to start operations upon completion of the road to the property. The company's officers are: A. F. Judd, of Honolulu, president; C. G. Bokus, secretary; H. G. Ginaca, of San Francisco, general manager.

Bibl.: U. S. G. S. Bull. 427, pp. 162-163.

Camp Bessie Mine. (See Fable Manganese Mine.)

Davenport Prospect is on the Winship properties near the center of the north line of section 27, T. 5 S., R. 4 E., $\frac{1}{2}$ mile east of the Arroyo Mocho Road and 25$\frac{1}{2}$ miles from Livermore. Rather siliceous manganese oxide occurs in chert which strikes N. 70° W., and dips 65° S. When visited only one prospect hole five feet deep had been sunk.

Davenport and Smith Prospect is on the Winship properties in the NE. $\frac{1}{4}$ of section 27, T. 5 S., R. 4 E., $\frac{1}{2}$ mile from the Arroyo Mocho road and 25 miles from Livermore. At the extreme northwest end of the claim an inclined shaft follows the ore on its dip southwest for 25 feet. Southeast of this, ore is exposed in trenches. Ninety feet southeast of the shaft there is a drift running nearly northwest along the strike of the ore body. Southeast still farther more trenching has been done, and finally, at the extreme southeast end, 300 feet from the shaft, a short tunnel exposes as much as five feet of massive siliceous manganese oxide striking N. 50° W., and dipping 25° to 75° SW. This body is considerably broken by minor shearing, and varies in width, averaging possibly two and one-half feet.

Doak Mine No. 2 is in the Red Mountain district 25 miles southeast of Livermore on the Camp Bessie Road, in sections 22-27, T. 5 S., R. 4 E., M. D. M. A few open cuts and short tunnels have been driven on some heavy croppings of manganese stained jasper, developing a vein

of manganese said to be 4 feet in width. Considerable ore has been produced from this deposit, but it is now idle. D. P. Doak, of San Francisco, is the owner.

Bibl.: Bull. 38, p. 337.

Fable Manganese Mine, in SW. ¼ of NE. ¼ of section 34, T. 5 S., R. 4 E., is in a small cañon tributary to the Arroyo Mocho, about 26 miles southeast of Livermore. The ore, a soft black oxide is deposited in an irregular layer varying from 6″ to several feet thick, interbedded in greenish-gray jasper, which has a strike a little west of north, and a dip of 45° to the west. Developments consist of a series of open cuts along the outcrop and a 100-foot tunnel driven on the vein showing 6 feet of ore. An incline shaft located near mouth of tunnel was sunk on vein to a depth of 18 feet, but it is now filled up. Idle. Thomas Green, of Dublin, California, is the owner.

Bibl.: Bull. 38, p. 337, U. S. G. S. Bull. 427, p. 162.

Keller Brothers have a slightly developed prospect of manganese in section 13, T. 6 S., R. 4 E., in San Antone Valley. No ore had been developed when the property was last visited.

Mammoth Prospect is owned by H. H. Ballantine and leased to John Plattner. The claim is in section 13, T. 6 S., R. 4 E., ¾ of a mile east of a point which is 32 miles from Livermore on the Arroyo Mocho Road. Several open cuts expose three to six feet of massive, rather siliceous manganese oxide in chert. No production is reported.

Mineral Products Company owns two unnamed prospects ½ mile east of the Black Bird Prospect, near the east line of section 28, T. 6 S., R. 5 E. Large, angular blocks of oxides of manganese occur here. A little work has been done. In the NE. ¼ of the same section a trench 60 yards long has been made and a small amount of oxide ore is exposed. No recent work has been done here.

Mateos Ranch Deposit. It is in section 8, T. 6 S., R. 2 E., eight miles by road east of Milpitas, in Alum Rock Cañon, about two miles beyond the park. There is no road connecting with the terminus of the electric railway at the park, so that at present, the ore has to be hauled over a mountainous road eight miles to the railroad station at Milpitas. A connection with the Alum Rock Cañon road could be made by constructing one-half mile of road.

The manganese ore occurs in seams and pockets in the jasper beds. Considerable high grade float is found in the cañon and a few large boulders aggregating several tons in weight, are lying in a small ravine near junctions with the main cañon. The ore, however, is intermixed with the jasper, and consequently low grade.

A tunnel was driven forty years ago in the jasper beds, and it is reported that some high grade ore was shipped. It is now caved and inaccessible. About 200 ft. west of the tunnel and at the same elevation, an open cut was made last year and about 40 tons of ore was shipped. The face of the cut is caved, so that no ore is at present exposed. Judging from the amount of float found in the cañon and

the extent of the manganese stained croppings, the property appears favorable for further development. It is idle. John D. Mateos, 165 North Fifteenth street, San Jose, California, is the owner.

Newhall Mine ("Great Expectations" Claim), E. P. Newhall, box 354, Livermore, owner; Horace B. Chase, 57 Post street, San Francisco, lessee. It is in section 36, T. 5 S., R. 4 E., on the headwaters of Colorado Creek, a branch of Black Bird Valley 29 miles southeast of Livermore. Some development work has been done by the owner; but he has recently (November, 1917) leased the property. The lessee has some ore out ready to ship showing both carbonate and oxide and said to analyze 42% manganese. The mine is three miles by wagon road from the main Arroyo Mocho road leading to Livermore. The ore is reported to show three feet in width.

Pennsylvania Manganese Mine. The property comprising two unpatented claims is in SE. ¼ of section 12, T. 7 S., R. 4 E., 35 miles southeast of Livermore via the Arroyo Mocho road. The jasper beds with interbedded lenses of manganese ores outcrop for about 500 ft. along the strike, which is northwest, in places showing high grade ore. Development work consists only of a few trenches along the outcrop. About 100 tons of ore, which appears to run high in silica, is lying on the several dumps. The property is worked for assessment only, and the owner is willing to lease on a royalty basis. Sufficient work has not been done to justify an opinion as to its importance. Morgan M. O'Day, 58 N. Fifteenth street, San Jose, is the owner. The Noble Electric Steel Company leased this property but discontinued work after shipping some ore.

On the **Wallace Ranch,** in section 8, T. 6 S., R. 2 E., 6½ miles by road east of Milpitas, a small cropping of high grade manganese ore was observed. This deposit adjoins that of the Mateos Ranch, to the northwest, and is evidently a continuation of the same beds. The jasper here outcrops prominently in bold ledges over large areas, but for the most part it is free from managnese stainings. The only ore observed in place was that exposed for a width of 12″ in a small cut, about 100 ft. in elevation above the old tunnel on the Mateos Ranch. Ore taken from this deposit is reported to have assayed 50.8% metallic manganese. It is undeveloped. Mrs. Grace P. Wallace, 164 East San Carlos street, San Jose, is the owner.

Winship Properties. K. D. Winship, 350 Post street, San Francisco, owner. In the northeast corner of Santa Clara County, in the upper part of the Arroyo Mocho, these properties include the following sections containing manganese prospects: section 27 and section 35, T. 5 S., R. 4 E., M. D. M.

In the SW. ¼ of section 27, on the west side of the Red Mountain-Livermore road, at a point well above and easily accessible to the road is a series of manganese veins covering a width of about 50′. These croppings are traceable for a distance of at least a couple hundred yards long, running west of north. It could probably be followed much farther, but the chamise brush is very thick at this point. A little work was done some years ago around these outcroppings, and it is stated a few tons of high grade ore hauled out. Material from there

could be easily handled by a gravity tram to a loading point on the Arroyo Mocho road.

On the NE. ¼ of this same section 27, is a good prospect of manganese ore. Some work was done a few years ago, said to have been by the same parties who worked on the SW. ¼. A short tunnel, now caved, is stated to have cut through a 4′ vein of high grade ore. The surface indications are that it is at least that wide. The strike is west of north. There are other exposures on this same lead, to the south for about 200′-300′. This deposit is on the east side of the Arroyo Mocho road in an ideal location for a gravity tram to handle the ore to bunkers. In April, 1916, E. A. Wiltsee took a lease on these deposits on section 27 and did a little preliminary development work, but nothing further. Holbrook & McGuire, as sub-lessees, shipped a couple carloads of manganese ore from this section in 1917, but none since.

MINERAL WATERS.

The numerous mineral springs of Santa Clara County are not confined to any particular locality or zone, but occur in the mountain ranges along both sides of the valley. They are all easily accessible and attractively located, and at the more important ones, recreation parks or health resorts have been established, while at others, the waters are bottled for medicinal and table uses.

Most of the springs are carbonated and of small flow, a few are essentially sulphur springs, but the best known is a hot spring of large flow, Gilroy Hot Springs, which has been famous as a health resort for many years.

Dr. Winslow Anderson in his valuable book "Mineral Springs and Health Resorts of California" calls attention to the medicinal value of several of the springs, comparing them favorably to the famous waters of Europe, and in writing of the California springs, in general, states that "all that is needed to make them as serviceable in the restoration and maintenance of health as their famous sister springs in the East and in Europe is their further development, their chemical analysis, and the scientific administration and application of their waters."

Alma Soda Spring. A small carbonated spring issues from a clay bank in a ravine one mile from Alma Station, in the Santa Cruz Mountains. The water, containing principally magnesia, soda and iron is bottled and distributed locally for table uses, by C. Wood, 315 Willow street, San Jose. The San Jose Water Company is the owner.

Alum Rock Park Springs. A group of mineral springs issue from the banks along the sides of Alum Rock Cañon, 7 miles northeast of San Jose. The country rock here is thin bedded sandstone and shales highly tilted and folded. The springs are all of small flow and slightly sulphureted. They vary greatly in their chemical characteristics, as will be seen by referring to the analyses below, extracted from U. S. G. S. Water Supply Paper No. 338. Most of the springs have been improved by cement basins to form drinking pools, and water from several of them is piped to the baths.

Analyses of Water from Alum Rock Park Springs, Santa Clara County, California.

(Constituents are in parts per million.)

	1		2		3		4		5		6		7		8	
Properties of reaction:																
Primary salinity		38		33		69		36		28		25		39		42
Secondary salinity		0		0		14		0		0		0		0		0
Tertiary salinity		0		0		0		0		0		0		0		0
Primary alkalinity		48		49		0		53		60		39		28		33
Secondary alkalinity		14		18		17		11		12		36		33		25
Tertiary alkalinity		104		91		10		80		61		2		2		42
Constituents	By weight	Reacting values	By weight	Reacting values	By weight	Reacting values	By weight	Reacting values	By weight	Reacting values	By weight	Reacting values	By weight	Reacting values	By weight	Reacting values
Sodium (Na)	1,320	57.40	870	38.22	1,751	76.16	2,110	91.77	1,652	71.80	583	25.35	657	28.50	856	37.24
Potassium (K)	25	.64	24	.61	45	1.16	77	1.96	25	.64	15	.39	13	.34	15	.38
Lithium (Li)	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
Ammonium (NH_4)									0	.00	0	.00	0	.00	0	.00
Calcium (Ca)	142	7.11	101	5.02	423	21.10	164	8.16	127	6.33	198	9.86	161	8.02	152	7.60
Magnesium (Mg)	24	2.14	39	3.18	160	13.19	39	3.18	37	3.05	58	4.78	73	6.02	63	5.21
Iron (Fe) / Aluminum (Al)	5.9	.21	3.5	.13	6.9	.25	4.2	.15	.6	.02	1.9	.07	30	1.06	5.4	.19
Manganese (Mn)									0	.00	0	.00	0	.00	0	.00
Sulphate (SO_4)	197	4.10	205	4.28	2,418	50.34	10	.21	18	.38	305	6.36	390	8.11	290	6.04
Nitrate (NO_3)									0	.00	0	.00	0	.00	0	.00
Chloride (Cl)	765	21.60	404	11.39	1,522	42.95	1,323	37.35	800	22.58	133	3.75	308	8.68	534	15.05
Bromide (Br)									0	.00	0	.00	0	.00	0	.00
Iodide (I)									Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
Carbonate (CO_3)	1,936	41.20	934	31.12	546	18.21	1,995	63.50	689	22.96	908	30.27	785	26.18	880	29.34
Metaborate (BO_2)	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace	0	.00	0	.00	Trace	Trace
Arsenate (AsO_4)									0	.00	0	.00	0	.00	0	.00

Phosphate (PO_4)	12	.39	10	.32	3.4	.11	32	1.01	Trace	Trace	0	.00	Trace	Trace	0	.00
Silica (SiO_2)	20	.66	22	.73	60	1.99	21	.70	31	1.03	26	.85	26	.87	25	.82
	3,746.9		2,621.5		6,935.3		5,775.2		3,379.6		2,227.9		2,443		2,820.4	
Carbon dioxide (CO_2)	1,483	67.41	888	38.09	192	8.73	1,835	83.41	1,093	49.66	16	.37	0	.00	447	20.34
Hydrogen sulphide (H_2S)	37	2.17	68	3.99					0	.00	10	.59	13	.77	13	.76

1. Blue Sulphur Spring. Analyst, William Irelan, Jr. Authority, advertising matter.
2. White Sulphur (Sulphur tunnel No. 1). Analyst, William Irelan, Jr. Authority, advertising matter.
3. Salt-Condiment Spring. Analyst, William Irelan, Jr. Authority, advertising matter.
4. Soda Spring. Analyst, William Irelan, Jr. Authority, advertising matter.
5. Soda Spring (on west side of creek, 100 yards north of baths). Analyst and authority, W. D. Forbes (1910). Possibly the same spring as that represented by the preceding analysis.
6. Sulphur Spring (75 yards northwest of tea garden). Analyst and authority, W. D. Forbes (1910).
7. Blackwater Spring (west of tea garden.) Analyst and authority, W. D. Forbes (1910).
8. Southernmost of three springs at Blackwater Spring house. Analyst and authority, W. D. Forbes (1910).

This property, owned by the city of San Jose, is conducted as a recreation park and is equipped with a swimming pool, tub baths, cafe, and numerous concessions. The Peninsular Railway operates an electric line to the park.

Bibl.: Repts. XII, p. 345; XIII, p. 518. U. S. G. S. Water Supply Paper No. 338, pp. 208-210. Mineral Springs and Health Resorts of California, by Dr. Winslow Anderson, pp. 78-80.

Azule Mineral Spring[1] is situated in a ravine a mile northward across a divide from Congress Springs. It was first known as Mills Seltzer Spring, but the name was early changed to Azule, from the blue appearance of the mountains to the southwest. The water was formerly bottled for table use, but it has not been on the market since about 1890. The property has, however, been improved as a picnic resort.

The spring rises in a small concrete house, from a crevice in dark-colored sandstone. Water also issues beside the spring house, apparently from the same crevice as that within the house, and the combined flow of the two streams is perhaps a quarter of a gallon a minute. The water is strongly carbonated and also tastes slightly of hydrogen sulphide. A very small deposit of Epsom salt was noticed beside the

Analyses of Water from Azule Mineral Spring and Congress Springs, Santa Clara County, California.

(Constituents are in parts per million.)

	1		2		3	
Temperature	16°C. (60°F.)				10°C. (50°F.)	
Properties of reaction:						
Primary salinity	39		42		43	
Secondary salinity						
Tertiary salinity						
Primary alkalinity	13		11		36	
Secondary alkalinity	48		47		21	
Tertiary alkalinity	140		136		42	
Constituents	By weight	Reacting values	By weight	Reacting values	By weight	Reacting values
Sodium (Na)	972	42.25	990	43.03	1,746	75.90
Potassium (K)	126	3.21	117	2.86	20	.51
Calcium (Ca)	69	3.44	62	3.08	181	9.05
Magnesium (Mg)	462	38.02	462	37.99	144	11.87
Iron (Fe)					115	4.10
Aluminum (Al)					41	4.52
Sulphate (SO_4)					378	7.87
Chloride (Cl)	1,212	34.17	1,280	36.10	1,201	33.89
Carbonate (CO_3)	1,582	52.75	1,526	50.86	1,790	59.67
Silica (SiO_2)	55	1.82			68	2.26
	4,478		4,437		5,684	
Carbon dioxide (CO_2)	2,632	119.64	2,606	118.46	756	34.36

1. Azule Mineral Spring: analyst and authority, Winslow Anderson (1888).
2. Azule Mineral Spring (bottled water): analyst, James Howden; authority, U. S. Geol. Survey, Bull. 32.
3. Upper Spring, Congress Springs: analyst and authority, Winslow Anderson (1888.)

[1]Gerald A. Waring, Springs of California, U. S. G. S. Water Supply Paper 338, pp. 212–213.

spring, and the channel is iron stained for a few yards below it. There are small deposits of lime carbonate farther downstream.

Although the spring issues from sandstone, serpentine that appears to form a dike not much more than 10 yards thick is exposed on the slope immediately above it. This dike may determine the position of the spring at this point, and the considerable amount of magnesia in the water that is shown by the following analyses, tabulated with one from Congress Springs, is probably explained by the presence of the serpentine. The water may be classed as secondary alkaline and primary saline, but the unusually large content of magnesium is noteworthy.

Bibl.: Rept. XIII, p. 518. Dr. Winslow Anderson's Report (1888), pp. 90-91.

Blodgett Magic Spring is located seven miles west of Gilroy in Bodfish Cañon. [1] "The water issues in a board-curbed and inclosed pool near camp grounds, at the base of the cañon side 25 yards east of the stream. It is not strongly mineralized, but tastes slightly saline and is mildly sulphureted and carbonated. * * * The analysis shows a primary and secondary alkaline water with notable tertiary alkalinity and primary salinity. In former years it was bottled and sold locally to a small extent. The water issues from soft white sandstone.

"A spring that is known as the **Blodgett Mineral Spring**, or Magnesia Spring, is situated on the hillside above a branch of Bodfish Creek and several miles north of Blodgett Magic Spring. It issues from ser-

Analyses of Water from Blodgett Mineral Spring and Blodgett Magic Spring, Santa Clara County, California.

(Analyst and authority, Winslow Anderson, 1889; constituents are in parts per million.)

	Mineral		Magic	
Properties of reaction:				
Primary salinity		45		28
Secondary salinity		16		
Tertiary salinity				
Primary alkalinity				21
Secondary alkalinity		39		51
Tertiary alkalinity		57		50
Constituents	By weight	Reacting values	By weight	Reacting values
Sodium (Na)	111	4.83	129	5.61
Potassium (K)	34	.88	4.7	.12
Calcium (Ca)	30	1.48	61	3.05
Magnesium (Mg)	68	5.62	37	3.03
Iron (Fe)	Trace	Trace	Trace	Trace
Aluminum (Al)	Trace	Trace	37	4.15
Sulphate (SO_4)	222	4.63	42	.88
Chloride (Cl)	112	3.15	85	2.40
Iodide (I)	Trace	Trace		
Carbonate (CO_3)	151	5.03	256	8.53
Metaborate (BO_2)	Trace	Trace	Trace	Trace
Silica (SiO_2)	93	3.08	70	2.33
	821		721.7	
Carbon dioxide (CO_2)	32	1.45	79	3.58
Hydrogen sulphide (H_2S)	48	2.81	Trace	Trace

[1] G. A. Waring op. at pp. 273–274.

pentine and its water is piped from a small covered and rock-walled basin 1 mile eastward to a tank near a farmhouse. The following analysis of the water shows that besides containing a large proportion of magnesia, the water of the mineral spring is primary and secondary saline in character."

Coes Spring. A carbonated spring rises in a creek bed on the east slope of Pine Mountain, 11 miles east of Madrone. It is not utilized commercially. An analysis of the water is given with that of Madrone Spring following.

Bibl.: Rept. XIII, p. 518. U. S. G. S. Water Supply Paper 338, pp. 214-215.

Congress Springs, formerly known as the **Pacific Congress Springs,** are in Campbell Creek Cañon, at the base of the Santa Cruz Mountains, 12 miles southwest of San Jose. A group of three springs, two of which are strongly carbonated, flows from the bank of the creek. Considerable gas escapes from the largest of the springs, the waters of which were formerly piped to a bottling plant below the springs. The gas was collected in a tank placed over the spring and utilized in charging the water, 5000 gallons of which were annually bottled and sold for table use. This property, before the burning down of the hotel in 1904, was a popular health and pleasure resort, but is now used only as an outing or recreation park. It is owned by the Peninsular Railway Company. The analysis given in the table with the Azule Springs is of the main spring.

Bibl.: Repts. XII, p. 345; XIII, p. 519. Water Supply Paper 338, p. 212. Winslow Anderson's Report, pp. 213-214.

Gilroy Hot Spring is situated 13 miles northeast of Gilroy on a hillside above Coyote Creek at an elevation of 1240 feet. There is one large mineralized spring here, which flows from a bank in a small ravine at a temperature of 112° F. It is housed in a bottomless concrete tank, from which the water is piped to tub baths and plunges. The flow is approximately 15 gals. per minute. The water is said to be efficacious in the alleviation of rheumatism, kidney, liver, stomach, skin, and blood diseases. Besides its uses for bathing, it is used for drinking, and it was formerly carbonated and bottled at Gilroy. The health resort established at this property in 1865 is one of the best known in California. There are hotel and cottage accommodations for 150 guests, and it is open throughout the year. A daily auto stage service from Gilroy to the springs is maintained throughout the summer. W. J. McDonald is the proprietor.

Bibl.: Rept. XIII, p. 518. Water Supply Paper 338, pp. 81-82. Winslow Anderson's Report, pp. 156-158.

Analysis of Water from Gilroy Hot Springs, Santa Clara County, California.

(Analyst and authority, Winslow Anderson, 1888; constituents are in parts per million.)

Temperature	43° C. (110°F.)
Properties of reaction:	
Primary salinity	60
Secondary salinity	31
Tertiary salinity	0
Primary alkalinity	0
Secondary alkalinity	9
Tertiary alkalinity	62

Constituents	By weight	Reacting values
Sodium (Na)	228	9.93
Potassium (k)	17	.42
Calcium (Ca)	66	3.30
Magnesium (Mg)	43	3.57
Iron (Fe)	2.1	.075
Sulphate (SO_4)	185	3.85
Chloride (Cl)	422	11.91
Iodide (I)	Trace	Trace
Carbonate (CO_3)	46	1.53
Arsenate (AsO_4)	Trace	Trace
Silica (SiO_2)	57	1.88
	1,066.1	
Carbon dioxide (CO_2)	114	5.16
Hydrogen sulphide (H_2S)	61	3.58

Grant Spring is situated in Alum Rock Cañon, 5 miles above the park. It is a slightly mineralized spring of small flow, whose waters contain principally sodium and magnesium carbonates. The water is bottled at the spring and distributed locally for table and medicinal uses by J. W. Shannon, 343 South Eighth street, San Jose, who has it under lease. J. D. Grant is the owner.

Bibl.: Water Supply Paper 338, p. 212.

Hillydale Sulphur Spring.[1] A small sulphur spring is situated on property known as Hillydale, about 4½ miles south of the reduction works of the New Almaden quicksilver mine, or 20 miles by road southward from San Jose. The spring is on the western bank of a stream, 200 yards from the house on the place, and yields about one-half gallon a minute of moderately sulphureted water. The following analysis indicates a primary-saline, secondary-alkaline water whose total mineral content is small.

[1]Water Supply Paper 338, pp 271–272.

Analysis of Water from Hillydale Sulphur Spring, Santa Clara County, California.

(Analyst, F. T. Green, 1904; authority, owner of spring; constituents are in parts per million.)

Properties of reaction:	
Primary salinity	57
Secondary salinity	0
Tertiary salinity	0
Primary alkalinity	6
Secondary alkalinity	37
Tertiary alkalinity	6

Constituents	By weight	Reacting values
Sodium (Na)	95	4.12
Calcium (Ca)	32	1.60
Magnesium (Mg)	9.5	.78
Iron (Fe) } Aluminum (Al)	1.0	.04
Sulphate (SO_4)	39	.81
Chloride (Cl)	104	2.93
Carbonate (CO_3)	83	2.76
Silica (SiO_2)	11	.37
	374.5	
Hydrogen sulphide (H_2S)	Present	Present

The water is used locally for drinking and is considered useful medicinally.

The spring is situated at the base of a basaltic slope, in an area of sedimentary rocks that may belong to the Franciscan formation. The rock near the spring contains much calcite and is stained with metallic sulphides, from which the sulphide constituents of the water are possibly derived.

Madrone Spring is situated 14 miles east of Madrone Station, and about 5 miles north of Gilroy Hot Springs, on a tributary of Coyote Creek. The spring issues at edge of creek, and the water, which is strongly carbonated, is caught in a cement basin. It was formerly hauled in barrels to San Jose and bottled, but is now used only for drinking purposes about the place. There are several other springs which are only slightly mineralized on the property. A resort was established here over thirty years ago, and it is open each year from May 1 to November 1. There are hotel and cottage accommodations for about 50 guests. Owners, J. D. Arnold, et al., Madrone, California.

Bibl.: Rept. XIII, pp. 518-519. Water Supply Paper 338, p. 214. Winslow Anderson's Report, p. 191.

Analyses of Water from Madrone and Coes Springs, Santa Clara County, California.

(Authority, 13th California; constituents are in parts per million.)

	1		2	
Properties of reaction:				
Primary salinity		1		3
Secondary salinity				
Tertiary salinity				
Primary alkalinity		29		8
Secondary alkalinity		70		89
Tertiary alkalinity		12		18
Constituents	By weight	Reacting values	By weight	Reacting values
Sodium (Na)	217	9.45	56	2.45
Potassium (K)	7.5	.19		
Lithium (Li)	Trace	Trace		
Barium (Ba)	1.2	.02		
Strontium (Sr)	Trace	Trace		
Calcium (Ca)	380	18.94	90	4.47
Magnesium (Mg)	37	3.04	182	14.94
Iron (Fe)	4.7	.17	21	.74
Aluminum (Al)			Trace	Trace
Manganese (Mn)	.8	.03		
Sulphate (SO_4)			27	.57
Chloride (Cl)	14	.40	6.4	.18
Carbonate (CO_3)	940	31.34	649	21.63
Metaborate (BO_2)	Trace	Trace		
Phosphate (PO_4)	3.2	.10	7.0	.22
Silica (SiO_2)	108	3.60	97	3.21
	1,713.3		1,135.4	
Carbon dioxide (CO_2)	Present	Present	Present	Present

1. Madrone Spring: analyst, G E Colby.
2. Coes Spring: analyst, M. E. Jaffa.

The **Santa Teresa Springs** are located on the east slope of the Santa Teresa Mountains overlooking the Santa Clara Valley, 3 miles south of Edenvale. The water, which is very slightly mineralized, issues from seams in a formation of hard gray sandstone, flowing over 20 gallons per minute. It is caught in a large concrete reservoir, from which the water is piped to the ranch house below, where it is bottled and distributed for drinking purposes to houses and offices in San Jose. Pedro A. Bernal, 404 S. Market street, San Jose, is manager. Mrs. Ygnacio Bernal, of Edenvale, is the owner.

Analysis of the Santa Teresa Spring Water.

(Constituents are in grains per gallon; analyst, Dr. H. Kleinhans; authority, advertising matter.)

Silica	5
Aluminum and Iron Oxide	1
Calcium Carbonate	8
Magnesium Carbonate	3
Magnesium Sulphate	2
Sodium Sulphate	4
Sodium Chloride	1
Total solids	24

There are several sulphur springs along Bodfish Creek, none of which are utilized commercially. One, larger than the rest, situated about 7 miles west of Gilroy, close to the wagon road, is used for drinking purposes by campers and teamsters.

NATURAL GAS AND PETROLEUM.

Natural gas and petroleum have been produced in the county at two localities, namely, in Moody's Gulch, south of Alma Station, and on the Sargent Ranch, near the southern boundary of the county. A number of wells were drilled at both of these localities, yielding some natural gas and oil. The first well was drilled in Moody's Gulch in 1878, and oil prospecting has been carried on there spasmodically to date. The Sargent field has been a producer only since 1900 (although wells were drilled there as early as 1886), yielding a few thousand barrels annually. Drilling has also been done northeast of Los Gatos, but no commercial production has resulted.

QUICKSILVER.*

The first known occurrence of quicksilver within the area of the United States, was that found at the New Almaden mine in Santa Clara County in 1824 by Antonio Suñol and Louis Chaboya. Though some occurrences had apparently been earlier noted in Mexico, the New Almaden was the first producing quicksilver mine in North America. Suñol and Chaboya built a mill nearby and endeavored to extract silver from the cinnabar. Late in 1845, the ore was shown to Andreas Castillero,[1] a Mexican officer, who identified it as cinnabar, and under whose direction development work was immediately begun. Gun barrels were utilized as their first retorts. The output was small, however, until after California became part of the United States, since which time more than a million flasks have been produced in this county, as may be noted from the tabulation herewith, the greater portion of which came from the New Almaden mine.

The quicksilver deposits of Santa Clara County are confined, with one exception, to what is known as the New Almaden district (see Plate II). This district lies east of south from San Jose, extending from the northeasterly foothills of the Gabilan Range on the west to the low foothills that lie between Coyote and Dry Creeks on the east. It also embraces the Santa Teresa Hills, a low spur ridge which lies between and in general parallel to the other two. The principal deposits are 8 to 13 miles from San Jose, on the ridge which forms the southwestern boundary of the Santa Clara Valley at this place, having a general NW.-SE. direction, and locally called the New Almaden Ridge.

The geology of this district and particularly of the New Almaden Ridge and its ore bodies has been described in considerable detail by various writers, especially by Becker[2] and by Forstner,[3] the latter of whom says:

*Much of this report on the quicksilver resources of Santa Clara County, particularly that with reference to plant equipment, is taken from Bull. No. 78, California State Mining Bureau, "Quicksilver Resources of California," by W. W. Bradley.

[1]Black's Supreme Court Reporter: The United States vs. Andreas Castillero: vol. 2, 1862. Also U. S. G. S., Mon. XIII, pp. 8–10, 1888.

[2]Becker, G. F., Geology of the quicksilver deposits of the Pacific Slope: U. S. Geol. Surv., Mon. XIII, pp. 310-330, 467, 1888.

[3]Forstner, Wm., Quicksilver resources of California: Cal. State Min. Bur., Bull. 27, pp. 168-171, 1903.

"The three ridges in which the deposits occur are to a great extent formed by serpentine, especially the two first named. The serpentine is associated with metamorphic sandstone and jaspilites. Large bodies of croppings can be found in each of these ridges, having also a general northwestern trend, but not coinciding with the backbone of the ridges.

"In the New Almaden ridge the most extensive orebodies have been found in and close to Mine Hill, the highest peak of the ridge, lying in its southeastern part. From this point going northwestward the croppings, while not continuous, can be traced along the ridge into the territory of the Guadalupe mine, a distance of about 3½ miles. At the surface the serpentine shows in large detached bodies surrounded by the sandstones and shales of the Franciscan series and having a general northwestern trend. This general direction of the serpentine exposures is important in connection with its occurrence underground, proven in the New Almaden mine. The line of ore croppings runs from Mine Hill to the American shaft, passing about 600 feet southwest of the Randol shaft. The underground workings in this territory have shown that the fissures wherein the orebodies have formed have invariably a serpentine footwall; hence the serpentine must be considered to occur underground in a continuous body through this entire territory and to be in places covered by overlying sandstones and shales. Southwest of Capitancillos Creek lies another parallel exposure of serpentine, contiguous to which the outcrops of the Costello mines are found. The Santa Teresa and Bernal mines are located in the serpentine of the Santa Teresa hills, and the North Almaden or Silver Creek mine close to those of the most northern ridge. In the latter a great part of the serpentine is very highly altered by silification, as also the sandstones, a great portion of the rocks being jaspilites. The western slope of the adjoining Mount Diablo range is nearly exclusively formed of shales.

"In this district the occurrence of cinnabar-carrying orebodies is clearly closely allied to that of serpentine, and as the New Almaden was the first extensively worked quicksilver mine in California, this association explains the reason why, for a considerable lapse of time, cinnabar ores were, in the opinion of most quicksilver miners, considered related to this rock formation. The croppings consist of a more or less weathered material having usually an ochreous color from the oxidation products of the iron sulphides, and traversed by a network of quartz seams, from a knife blade to quarter of an inch wide. Overlying the orebodies is almost invariably found a body of clay, generally black, and containing more or less inclusions of a dark-gray sandstone. As this clay overlies the ore bodies it has received the name of 'alta' (Spanish for 'high' or 'upper'). At the surface of this 'alta' crops as a light-gray material, resembling disintegrated sandstone, traversed by a network of very thin, yellowish-brown seams, often very much like a bunch of very fine roots. In places the same material can be found in the New Almaden mine several hundred feet below the surface, forming part of the 'alta.' * * * The rocks of the Franciscan series in this region show a great amount of silification. The chert beds are, however, almost entirely unrepresented.

"To the west of the New Almaden ridge a belt of bedded sandstone is exposed. The beds are from 3 to 5 feet thick and interbedded with thinner beds of shale. * * * The country west of the New Almaden ridge and south of Capitancillos Creek, belonging to the Gabilan mountain system, consists almost exclusively of the sandstones and shales of the Franciscan series with occasionally some jaspilites. * * * West of the serpentine belt which lies west of the New Almaden ridge, south of Costello's house, a small exposure of glaucophane schist was found. A body of rhyolite lies in the northern part of the New Almaden ridge, having a nearly east and west strike and being about two miles long."

The alta, or so-called clay referred to above, is not a substance of definite composition, though it is usually a dark or black mass, readily distinguishable even in hand specimens from the country rock. It is simply an attrition product of the country rock and varies in composition with the material from which it has been produced. Its black color is in part due to the presence of manganese.

With reference to the age of the formations in the New Almaden district, Becker[1] summarizes his observations in the following:

"Upon highly metamorphosed rocks lie Miocene sandstones, which were sharply folded at the Post-Miocene upheaval. They are not conformable with the lower series and contain pebbles from these older beds. In the older rocks near New Almaden Mr. Gabb found *Aucella*, proving the presence of the Knoxville series.

"In this district is the only mass of rhyolite thus far found in the Coast Ranges. It forms a dike nearly parallel to the line connecting the New Almaden and the Guadalupe. It is almost continuous, and I have followed it for a distance of several miles. It is certainly Post-Miocene and probably Post-Pliocene.

"The New Almaden is a very extensive mine * * *. The ore is cinnabar, with occasional traces of native quicksilver, accompanied by pyrite and marcasite, with rare

[1] *Op. cit.*, p. 467.

crystals of chalcopyrite. The gangue is quartz, calcite, dolomite, and magnesite. These materials were deposited in shattered masses of pseudodiabase, pseudodiorite, serpentine, and sandstone. * * *

"The other mines of the district contain similar ores in similar rocks. The Guadalupe was the most productive. * * *

"All the deposits of the district appear to occur along a rather simple fissure system. The main fissure is nearly parallel to the rhyolite dike at the Guadalupe. It follows the direction of the hills, the axis of which curves gradually away from the dike for a certain distance. Passing through or near the San Antonio and Enriquita, it seems to break across the ridge at the America and enters the Almaden on the strike of its two great fissures. It is near this fissure that new orebodies are most likely to be found. The Washington seems to be on a branch of the main fissure.

"This was probably formed at the time of the rhyolite eruption, to which also I ascribe the genesis of the ore."

Also:[1]

"This dike not only proves the former existence of volcanic activity in this district, but emphasizes a fundamental structural axis. The character of the metamorphic rocks shows that the line along which compression and upheaval took place in the early Cretaceous was about west by north, east by south. The folding of the Tertiary rocks shows that compression was repeated in the same direction at the close of the Miocene. The position of the rhyolite dike proves that the dislocation which opened a passage for this lava again followed a similar course."

Also:[2]

"Ore deposition followed the eruption of lava. The minerals deposited and the manner of their deposition are such as in the more northerly quicksilver districts were induced by volcanic springs. Though there are now no indubitable remnants of the volcanic activity which certainly prevailed here since the beginnng of the Pliocene, the analogies of the deposit, together with the presence of lava of approximately the same age as the ore, make any theory of deposition excepting from hot sulphur springs improbable."

There have been but two mines of consequence developed in this district, the New Almaden and Guadalupe, though there are a number of small properties which have at times produced a few flasks of quick-

[1] *Idem*, p. 314.
[2] *Idem*, p. 328.

PHYSICAL
SCIENCES
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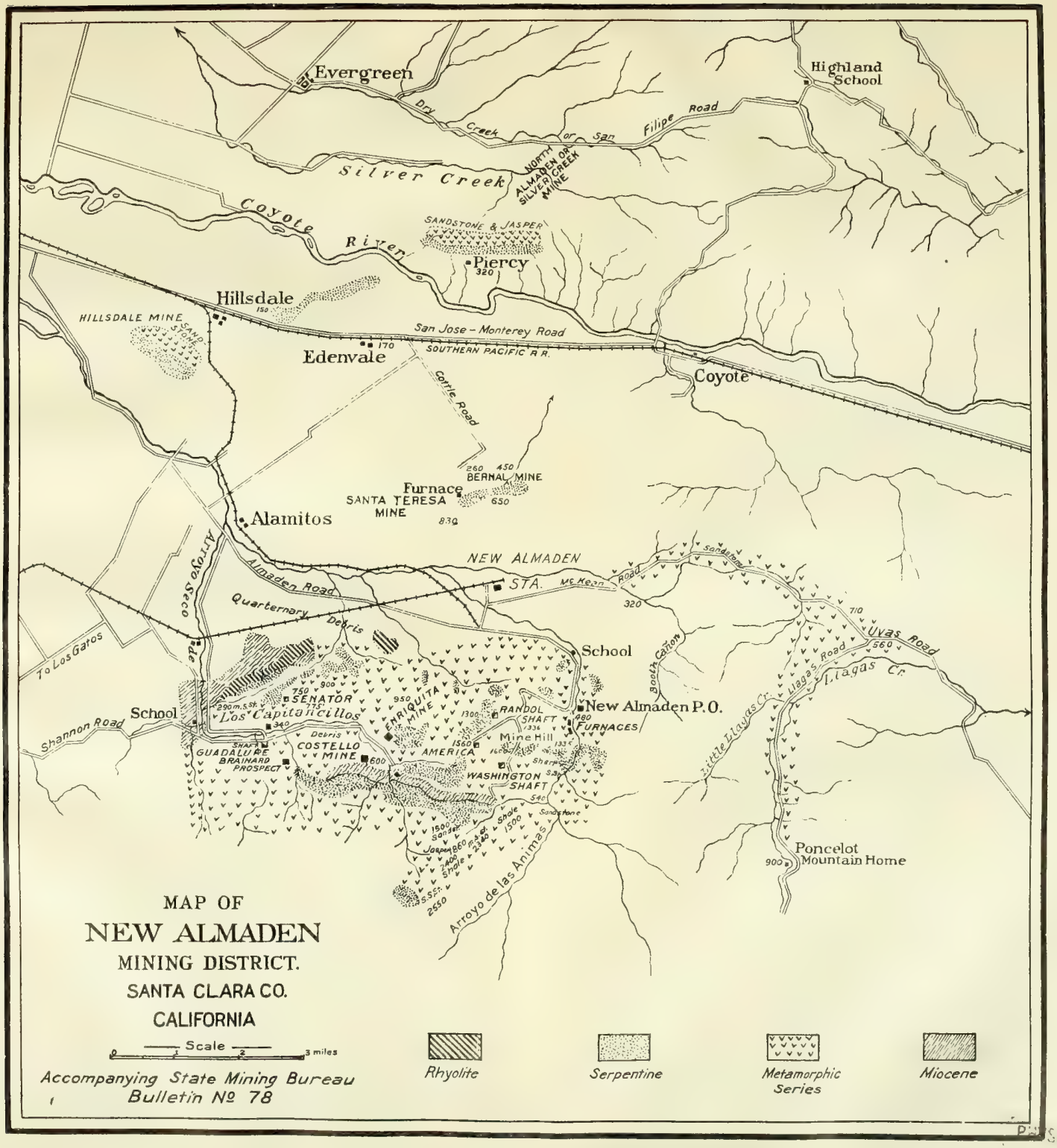

Plate II. Map of New Almaden Mining District.

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Table of Mineral Production of Santa Clara County—1850 to 1918, Inclusive.

Year	Quicksilver		Mineral water		Petroleum		Brick		Clay		Sandstone		Limestone		Stone industry value	Magnesite		Miscellaneous and unapportioned	Value
	Flasks	Value	Gallons	Value	Barrels	Value	M	Value	Tons	Value	Cubic feet	Value	Tons	Value		Tons	Value		
1850	7,723	$768,052																	
1851	2[illegible],779	1,859,248																	
1852	15,901	927,505																	
1853	22,284	1,235,648																	
1854	30,004	1,663,722																	
1855	29,142	1,560,554																	
1856	27,138	1,401,678																	
1857	28,204	1,374,381																	
1858	25,761	1,232,149																	
1859	1,294	81,690																	
1860	7,061	378,117																	
1861	34,429	1,447,739																	
1862	39,671	1,442,041																	
1863	32,803	1,380,350																	
1864	42,489	1,950,245																	
1865	47,194	2,166,205																	
1866	35,150	1,867,519																	
1867	24,461	1,122,760																	
1868	25,628	1,176,325																	
1869	16,858	775,618																	
1870	14,423	827,592																	
1871	18,568	1,171,641																	
1872	18,574	1,224,584																	
1873	11,042	887,004																	
1874	9,084	995,465																	
a	20,000	1,008,000																	
1875	16,980	1,428,867																	
1876	27,930	1,228,920																	
1877	30,237	1,127,840																	
1878	24,924	820,000																	
1879	36,054	1,076,212																	
1880	30,135	934,185																	
1881	31,288	933,321																	
1882	29,208	824,542																	
1883	29,084	836,165																	
1884	20,000	610,000																	
1885	21,400	658,050																	
1886	18,000	639,000																	
1887	20,000	847,600																	
1888	18,000	765,000																	
1889	13,100	589,500																	
1890	12,000	630,000																	
1891	8,200	371,105																	
1892	5,563	226,170																	
1893	6,611	243,051																	
1894	7,235	222,169	5,000	$1,250	3,500	$8,590	22,725	$119,250			24,000	$8,292						Natural gas 80,000 cu. ft.	$4,072
1895	7,050	253,800	20,000	5,000	4,000	10,000	24,750	131,250							$33,900			Natural gas 800,000 cu. ft.	12,000
1896	6,222	211,570	44,000	18,800	900	1,145	15,000	80,000					500	$600	5,000			Natural gas	1,300
1897	4,760	169,200	39,500	17,600	4,000	10,000	19,000	105,000											
1898	5,875	235,000	25,863	11,358	3,000	6,000	13,098	65,490	200	$2,500					12,000				
1899	4,435	186,270	79,000	19,150	1,500	3,000	30,741	170,455					1,800	3,000	8,000	100	$1,350	32 tons asphalt	640
1900	5,145	241,073	30,000	8,060			20,000	136,000	2,000	6,000	120,000	100,000	8,000	6,000		39	253	5 tons manganese	75
1901	5,220	236,608	55,000	8,500			21,800	94,570			60,000	80,000			917	50	300	17 tons asphalt	255
1902	5,869	254,260	21,900	5,500			23,982	178,682			35,000	31,500						2,000 cu. ft. granite	1,200
1903	5,603	233,130	50,000	12,500	4,695	3,966	28,069	188,284			112,350	225,000	7,000	7,000	100			21 tons bituminous rock	47
1904	3,889	148,103	50,000	12,500	42,000	13,830	24,909	178,581							12,000			11 tons asphalt	132
1905	2,693	95,968	5,000	1,200	41,000	14,555	28,486	204,357	700	1,050	100,000	150,000			3,000				
1906	2,592	94,608	5,000	1,250	7,000	2,800	23,397	183,676	1,000	1,500			10,000	15,000					
1907	2,518	96,686	11,374	2,187	22,100	5,525	30,053	255,424			3,500	3,500	9,460	16,694					
1908	2,460	103,984	371,635	39,955	35,400	17,700	15,000	63,618					671	1,417	45,142			10,017 bbls. lime	10,017
1909	3,747	158,490	373,367	40,754	63,780	76,536	6,000	30,000					2,221	4,150	75,916	300	3,000	1,000 bbls. lime	1,000
																		Unapportioned 1900-1909	82,254
1910	4,038	182,719	182,500	11,250	36,660	31,659	12,000	66,000	12,000	66,000			4,284	3,451	68,765	7,560	51,937		
1911	7,533	346,593	165,720	10,000	12,828	8,205	6,000	30,000					2,417	3,918	62,595				
1912	8,695	365,538	152,500	10,250	14,092	8,295	18,000	105,000					3,374	4,120	48,228	600	6,000	13,508 bbls. lime	10,154
1913	3,709	149,213	101,000	10,750	20,000	12,000	18,000	95,000					3,549	4,200	29,377	70	560	13,107 bbls. lime	9,783
																		Natural gas 2,000 cu. ft.	500
1914	2,467	118,063	29,000	10,750	10,000	5,300	15,900	79,500							39,093	1,425	14,250		
1915	4,386	376,319	38,400	16,770	16,617	11,657	10,096	57,784							98,342	7,623	74,607	Other minerals	340
1916	4,016	375,496	50,000	11,300	16,368	10,901	13,100	82,800	2,024	2,293					111,974	23,207	232,156	Other minerals (b)	25,028
1917	5,921	639,594	10,230	1,923	18,855	26,152		80,000	6,014	4,929					111,304	9,963	99,287	Other minerals (c)	28,341
1918	3,977	478,524	13,025	1,678	20,499	34,848		62,000							111,860	9,746	121,872	Other minerals (d)	948,786
1919	3,012	271,762			16,724	26,695	7,250	65,000	2,532	2,232					73,237	10,912	128,924	Other minerals (e)	480,721
Totals	148,283	$54,049,803	1,929,014	$290,235	415,518	$354,010	447,356	$2,907,701	26,470	$86,504	454,850	$598,292	51,276	$69,550	$950,750	60,685	$605,592		$1,598,773

TOTALS

Brick	$2,907,701
Clay	86,504
Limestone	69,550
Magnesite	734,496
Mineral water	290,235
Petroleum	354,010
Quicksilver	54,049,803
Sandstone	598,292
Stone industry	950,750
Miscellaneous and unapportioned	1,616,645
	$61,656,976

(b) Chromite, limestone and manganese.

(c) Chromite, manganese, tile and limestone.

(d) Chromite, manganese, clay, tile, potash.

(e) Manganese, limestone, mineral water and potash.

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silver. The total recorded output of quicksilver from this county is given in the following tabluation:

Quicksilver Production of Santa Clara County.

Year	Flasks	Value	Year	Flasks	Value
1850	7,723	$768,052	1886	18,000	639,000
1851	27,779	1,859,248	1887	20,000	847,6 0
1852	15,901	927,5.5	1888	18,000	765,000
1853	22,284	1,235,648	1889	13,100	589,500
1854	30,004	1,633,722	1890	12,000	630,000
1855	29,142	1,560,554	1891	8,200	371,105
1856	27,138	1,401,678	1892	5,563	226,470
1857	28,204	1,374,381	1893	6,614	243,064
1858	25,761	1,232,149	1894	7,235	222,169
1859	1,294	81,690	1895	7,050	253,800
1860	7,061	378,117	1896	6,222	211,570
1861	34,429	1,447,739	1897	4,700	169,200
1862	39,671	1,442,041	1898	5,875	235,000
1863	32,803	1,380,350	1899	4,435	186,270
1864	42,489	1,950,245	1900	5,145	241,073
1865	47,194	2,165,205	1901	5,220	236,608
1866	35,150	1,867,519	1902	5,869	254,260
1867	24,461	1,122,760	1903	5,603	233,130
1868	25,628	1,176,325	1904	†3,889	148,103
1869	16,898	775,618	1905	2,693	95,938
1870	14,423	827,592	1906	2,592	94,608
1871	18,568	1,171,641	1907	2,518	96,086
1872	18,574	1,224,584	1908	2,460	103,984
1873	11,042	887,004	1909	3,747	158,490
1874	9,084	995,455	1910	4,038	182,719
	*20,000	*1,098,000	1911	7,533	346,593
1875	16,980	1,428,867	1912	8,695	365,538
1876	27,930	1,228,920	1913	3,709	149,213
1877	30,237	1,127,840	1914	2,467	118,063
1878	24,924	820,000	1915	4,386	376,319
1879	36,054	1,076,212	1916	4,016	375,496
1880	30,135	934,185	1917	5,921	639,594
1881	31,288	933,321	1918	3,977	478,524
1882	29,208	824,542	1919	3,012	271,762
1883	29,084	836,165			
1884	20,000	610,000	Totals	148,283	$54,049,803
1885	21,400	$658,050			

*Estimated production of Guadalupe Mine previous to 1875.
†Flasks of 75 pounds since June, 1904; of 76½ pounds previously.

Bernal Mine. Mrs. Ygnacio Bernal, owner, Edenvale. It is 10 miles southeast of San Jose, on the east slope of the Santa Teresa hills, at an elevation of about 450 feet. A tunnel, over 200′ long, was driven along a clay gouge and serpentine contact, many years ago; but failed to encounter any important ore body, so it was abandoned. No work has been done in recent years.

Bibl.: Cal. State Min. Bur. Bull. 27, p. 171; Bull. 78, p. 157.

Bowie Prospect, New Almedan district. Circle B. Mining Company, owner, Prospect only. Idle.

Brainard Prospect. This is on patented property owned by Mrs. M. D. Brainard et al. of San Jose, situated south of the Guadalupe mine, and west of the northern end of the New Almaden lands. There is an old adit in which it is stated some cinnabar-bearing material was cut, but there has been no work done in recent years.

Comstock Mine. T. H. French, owner, Lone Tree via Hollister. It is in the extreme southeastern corner of Santa Clara County, in section 19, T. 11 S., R. 7 E., M. D. M., and in the Stayton district most of which lies in San Benito County. The Comstock mine is located on the only surface exposure of serpentine found in the Stayton district. Abandoned some years ago.

Bibl.: Cal. State Min. Bur. Report XII, p. 367; Bull. 27, p. 172; Bull. 78, p. 157. Mineral Resources West of Rocky Mountains, 1875, p. 14.

Costello Mine. M. Costello, owner, New Almedan. It is about 1½ miles by road southeast of the Guadalupe mine, on the hillside above Los Capitancillos Creek at an elevation of about 1000′. It is a prospect only and no ore was found in place. It has been idle for a number of years.

Bibl.: Cal. State Min. Bur. Bull. 27, p. 172; Bull. 78, p. 157.

Guadalupe Mine. New Guadalupe Mining Company, owner; Hugh C. Davey, president; John L. Stubbs, vice president; Chas. W. Aby, treasurer; route A, Los Gatos. This property, covering a territory of 2500 acres, is situated 10 miles south of San Jose on the west slope of New Almaden Ridge, and adjoins the land of the New Almaden Company on the northwest. The mine was discovered in the early 50's and is said to have produced 20,000 flasks of quicksilver up to

Photo No. 18. Reduction plant at the Guadalupe Mine, looking southwestward from dump shown in Photo No. 20.

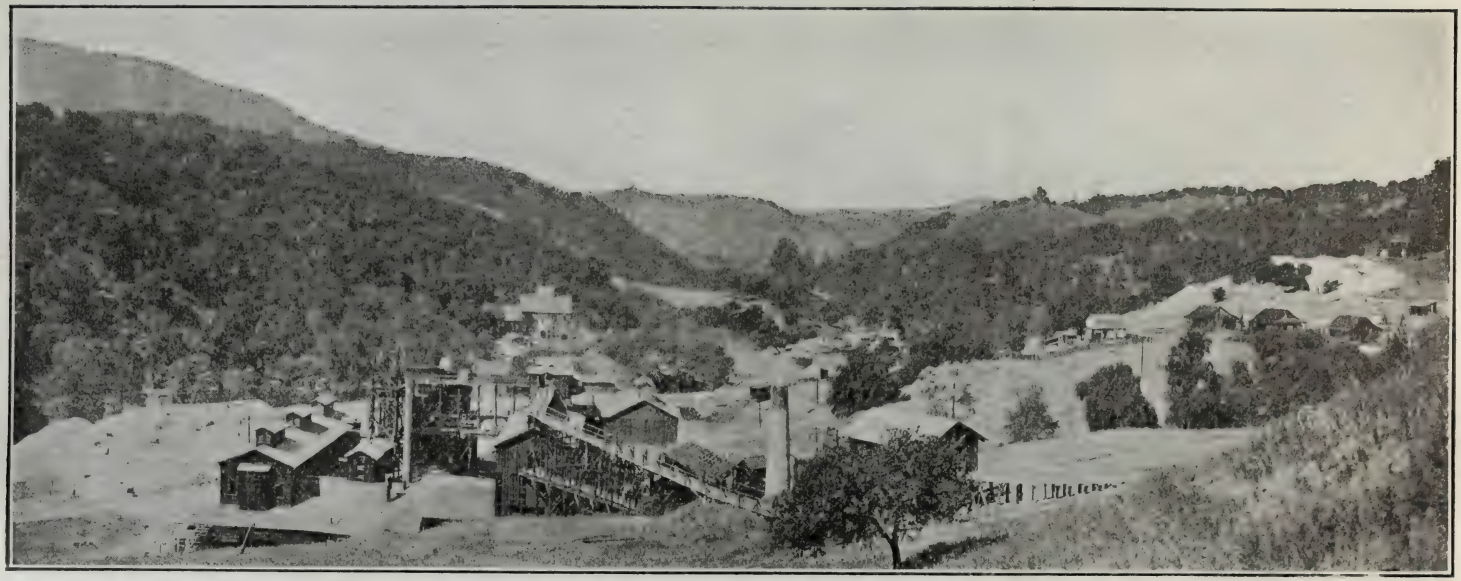


Photo No. 19. Guadalupe Mine, Santa Clara County. Furnaces in foreground; old vertical-shaft house in middle distance; main working incline shaft at extreme right. Photo by W. W. Bradley.

1875, when it became the property of the Guadalupe Mining Company. This company erected furnaces and made many surface improvements. In 1886 the mine was shut down due to litigation, remaining idle until 1900 when H. C. Davey, one of the present owners, organized the Century Mining Company. The old furnaces were remodeled, the mine unwatered, and operations resumed, since which time it has been an important and continuous producer.

The mine was first worked by a vertical shaft, 625′ deep, sunk on the south side of, and near the bottom of Capitancillos or Guadalupe Creek. It was very difficult to keep the surface water out of this shaft during the wet seasons, and it was finally abandoned. A 700 foot incline, which is now the main working shaft, was then sunk on the opposite side of the creek on the dip of the vein. It has three compartments down to 180′ on the incline (where it connects with No. 1 Tunnel, whose portal is just above the creek bed), and two compartments below that. There are many miles of underground workings in the Guadalupe. Several shallow shafts and drifts have been driven on different outcrops about the property, but mining in recent years has been confined to the main workings.

From the plan of the old workings, it appears that the ore body developed by the vertical shaft on the south side of the creek had a northwest strike and southwest dip. The second level, 300′ below the collar of the vertical shaft, connects with the incline shaft on the opposite bank of the creek. From the sixth level (625′) of the vertical shaft an incline winze was sunk from which the seventh, eighth and ninth levels were driven; but ore was developed only on the seventh and eighth levels. The ore of the Guadalupe mine is similar in appearance to that of the north-end New Almaden ground, being in part at least a silicified serpentine with cinnabar. There is some associated pyrite. In the latter part of 1917, the bed of the creek was replaced by a concrete flume, 740′ long and 55′ wide, with side walls 9′ high, to carry the stream over the portions of the old mine beneath. There is a 1′ high cross-wall every 100′ to hold the gravel and protect the flume floor from excessive wear. With this improvement in service, the mine was unwatered later. Electric power is used.

Equipment includes electric hoists, air compressors and machine drills. The reduction plant consists of two coarse-ore furnaces of 18 tons capacity each and two fine-ore furnaces of 30 tons capacity each, all oil-burning, and modeled after the Davey patents. The ore is broken to cobble size and sorted by hand in the mine, the waste being partly used to fill old stopes. At the surface, the ore is screened and then trammed by mule-drawn trains to the fine and coarse-ore furnaces respectively. The fine ore is passed through a rotary drier, 29′ long x 28″ diam. lined with one row of fire-brick, and driven by a 4-h.p. electric motor at 2 r.p.m. The discharge is directly into the feed end of the fine-ore furnace, in a sealed compartment to prevent escape of any mercury vapors that might be present.

A concentrating plant of 50 tons daily capacity was built, and started operating in February, 1917, handling material from the old mine dumps. Crushing is done in a ball mill with 20-mesh screen. After classification, the fine pulp goes to a Deister table, and the sand to two Wilfleys. The plant is driven by a 25-h.p. Semi-Diesel oil engine. The concentrates are said to assay 8%-10% mercury, and

are reduced in the fine-ore furnaces. In September, 1917, there were 75 men employed, 25 of whom were underground. Due to the "after the war" slump, the mine was closed down and has not been in recent operation. (June, 1919.)

Bibl.: Cal. State Min. Bur. Repts. VIII, p. 542; XIII, p. 600. Bull. 27, p. 173; Bull. 78, pp. 157-160. Mineral Resources West of Rocky Mountains, 1885, p. 13; 1876, p. 20. U. S. Geological Survey, Mon. XIII, p. 236.

Hillsdale or San Juan Bautista Mine (one time called **Chapman**; also **Chaboya**). Elizabeth Kohrs, owner: Hillsdale, via San Jose, R. F. D. It is about 2 miles southeast of San Jose on the east slope of the San Juan Bautista Hills, and within one-half mile of a street car line. These hills, an isolated group, composed of metamorphic rocks, largely serpentine, rise to a height of only a few hundred feet above the valley, and are a northward continuation of the Santa Teresa Range.

The mine is said to have been discovered in 1847 and worked to 1861 by Mexicans, subsequently becoming the property of a Mr. Chapman, who worked it up to 1874. In the spring of 1871, production was at the rate of 30-40 flasks of quicksilver per month. It lay idle from 1874 until 1892, when it was reopened by R. H. Harper, of San Jose, and worked spasmodically in a small way up to 1907. In 1915, under the name of New Discovery Quicksilver Company, a lease and bond was taken and a few flasks of quicksilver produced; but little work was done underground, and the lease forfeited. There are said to be over 4000 feet of underground workings, but most of the tunnels are now inaccessible, being caved. The reduction plant consists of two 12-pipe retorts, evidently built in later years, as they are in good condition.

Bibl.: Cal. State Min. Bur. Rept. XIII, p. 600; Bull. 27, p. 174. Geol. Surv. of Cal. Geol., Vol. 2, pp. 112-113.

New Almaden Mine (originally **Chaboy**, then **Santa Clara**). The Quicksilver Mining Company, owner; New Almaden Company, Incorporated, lessee; Geo. H. Sexton, president, 45 Broadway, New York; Chas. A. Frank, secretary and treasurer; Edmund Juessen, general manager, 57 Post street, San Francisco. This property, covering over 8000 acres, lies from 8 to 13 miles east of south from San Jose along the New Almaden Ridge, and was at one time second only in production to the famous Almaden mine in Spain, after which it was named. This property is the oldest known quicksilver mine in the United States, being first worked in 1824 by Antonio Suñol and Luis Chaboya. In 1845, Andreas Castillero, a Mexican army officer, "denounced" (located) it under the name of Santa Clara. After the admission of California into the Union, Castillero and associates leased the mine to Barron Forbes and Company, who changed the name to New Almaden. It has been worked continuously since 1845, but the greatest surface improvements were made after it became the property of The Quicksilver Mining Company in 1864.

Many important practices and appliances in the metallurgy of quicksilver had their beginning here, including the development of the Hüttner-Scott fine-ore furnace in 1875-1876. The present operating company took over the property under a lease and bond in 1915. The total production has been surpassed by only one mine in the world (Almaden mine, Spain) during the period in which New Almaden has been operating. Published records show that this total, however, has been exceeded by the Indria mine, Austria, and the Santa Barbara mine, Huancavelica, Peru, the bulk of whose production was made prior to 1850; in fact, Huancavelica has yielded but little quicksilver since 1800.

GEOLOGY AND MINE WORKINGS.

The New Almaden property really contains three mines, all of which are located on the same mineral belt: the great New Almaden mine proper, the Enriquita, and the Senator or El Senador, as the Mexicans named it (also referred to as the North Line mine). A distance of nearly 4 miles separates the first and the last named. The workings of the main New Almaden mine, cover a territory of about 2½ square miles, which is exclusive of the Enriquita and Senator; and their greatest depth is 2450 feet below the top of Mine Hill, which is the datum point for all underground workings. The elevation of Mine Hill is 1600′ above sea-level. In this territory 18 shafts have been sunk, and there are nearly 100 miles of underground excavations, much of which is at present inaccessible. Forstner[1] states that in 1903, the Victoria shaft, a short distance to the southwest of the Randol shaft, and the Harry shaft, on the southeast slope of Mine Hill were the only two shafts then in operation. The deepest workings then being followed were on the 1000′ level, as below 1300′ the mine was filled with water. Since that time, most of the work has been done through the Harry shaft and the Day tunnel, and more recently at the Senator mine.

Geology.

The geology of the New Almaden mine has been studied and described in considerable detail by a number of authors, the most important of whom was Becker. He states:[2]

"The ores * * * are composed of the usual association of minerals: cinnabar (sometimes accompanied by a little native mercury), pyrite, quartz, calcite, and dolomite, and more or less closely associated masses of bituminous matter. Accompanying the deposits is a small amount of chalcedony or opal, usually black in color, but this substance is much less abundant here than in the greater part of the northern mines. Dolomite is more prevalent as a gangue mineral here than in most quicksilver districts * * *.

"The rocks associated with cinnabar in this district include every variety of the metamorphic series. Where the rock happens to be a permeable sandstone, impregnations have resulted. Elsewhere the ore seems to occur exclusively in crevices in the rock * * *. I was unable to perceive any indication that ore had been deposited by substitution or that the rock had influenced the deposition of ore by its chemical properties. Ore is found with nearly equal frequency in contact with various rocks and the existence of fissures appears to have been the necessary and sufficient condition for the deposition of cinnabar and gangue minerals. * * *

"The ore in the New Almaden mine seems never to occur except close to evidences of faulting. This evidence consists in the presence of layers of attrition products, so-called clays, full of slickensides and of fragments of rocks more or less rounded by attrition. These layers of clay usually occur on the hanging sides of deposits and are known to the miners as atlas, the Spanish term for hanging-walls. The clays are impermeable to solutions and the ore usually forms on their lower side, as if the cinnabar had ascended and been arrested by the atlas. * * *

[1]Forstner, Wm., Quicksilver Resources of California: Cal. State Min. Bur. Bull. 27, p. 175, 1903.

[2]Becker, G. F., Quicksilver Deposits of the Pacific Slope: U. S. Geol. Surv. Mon. XIII, pp. 314 et seq., 1888.

"While the evidence of the existence of a fissure system is, if possible, more abundant in the New Almaden mine than in most quicksilver deposits of the Pacific Slope, the deposits themselves are of various types. The commonest is the reticulated mass, or stockworks, consisting of irregular bodies of broken rock into which solutions of cinnabar and gangue minerals have filtered, cementing the fragments together with ore. Where the disturbance has been less extensive and irregular, clean-cut fissures may sometimes be seen filled with ore, and these can only be classified as veins, though they are not persistent. * * *

"Certain features must be common to the ore bodies taken singly and to the ore-bearing ground as a whole. It would be impossible to suppose that each stockwork has an independent fissure system, and a mere glance at the mine map shows that a connection between them exists. It is also a historical fact that the thin seams of ore * * * have led from one ore chamber to another. * * *

"The distribution of serpentine, the average strike of the metamorphic strata, the compression of the Miocene beds, the position of the rhyolite dike, and the trend of the range, in short the whole structural geology of the region shows that the fundamental axis of disturbance must have a direction which is approximately northwest and southeast."

Also:[1]

"Considered in detail, the orebodies are stockworks; but they are arranged along definite fissures and the deposits as a whole have a vein-like character and answer to the 'chambered veins' defined in a subsequent paragraph. The workings have developed two main fissures. One of these dips from the surface at a high angle and in a nearly straight line. The other strikes in nearly the same direction as the first, dips steeply from the surface, then flattens and approaches the first fissure rapidly, again becomes very steep, and in the lowest workings almost coincides with the first. In vertical cross-section the two fissures form a figure resembling a V. The great ore bodies are distributed along these two fissures, making irregularly into the walls. The wedge between the fissures also contains ore bodies."

Mine Hill Workings.

The surface and workings of the New Almaden mine have been minutely surveyed and the data carefully preserved by the officers of the Quicksilver Mining Company in the form of a large, detailed, colored map which hangs in a specially constructed fireproof draughting room, adjoining the office at the Hacienda. An excellent reproduction of this map, up to the date of its publication, 1888, accompanies Becker's report.[2] The map herewith (Plate III) was compiled from the company's records and is reproduced herewith by courtesy of Mr. Edmund Juessen, general manager. The principal dumps are shown in brown with the surface contour lines. The principal ore bodies extracted since Becker's publication of the map, are indicated by: 1. The N.-S. line of stopes to the west of and nearest the Harry shaft. 2. The line of stopes lying approximately at right angles across the northwestern end of the older stopes, and extending southwesterly from the "mouth of Randol tunnel." 3. Portions of the stopes south of the Cora Blanca shaft.

The ore deposits are limited on their hanging wall side by the alta, which being an impermeable layer prevented the passage of water circulation. According to Forstner,[3] the footwall side is persistently serpentine, from which it is concluded that the serpentine, or rather the intrusive peridotite which has altered to serpentine, is the cause of the fracturing of the other rock strata.

"The fracturing has taken place on both sides of the serpentine, which apparently can not be considered otherwise than as an intrusive body having uplifted the rocks of the Franciscan series.

The orebodies form principally in those parts of the zones where the dip of the 'alta' is very flat * * *. The contact of the alta with the underlying vein filling,

[1] *Op. cit.*, p. 467.
[2] *Op. cit.*, Atlas Sheet IX.
[3] *Op. cit.*, p. 178.

and where this is missing with the serpentine, is very tortuous in both directions, vertically and horizontally, so that in the gangways, which * * * follow this contact, it is an exception to find a straight line of any length. The stopes are locally called 'labores.' The material which fills the zones of fracturing and wherein in places cinnabar forms, is generally rather hard and siliceous, traversed by a network of seams of quartz and dolomite, showing repeated fissuring and filling containing some inclusions of serpentine, the cinnabar forming principally in connection with the seams. In places the vein-filling has more of an ochreous character, the matrix being more or less leached out, leaving only the network of seams intact. * * *

"The general character of the vein-filling indicates that, as in most of the other quicksilver deposits in the State, the deposition of cinnabar has been associated with the process of silicification, which characterizes the alteration of the rocks of the Franciscan series.

"The general direction of the seams in the vein-filling is not parallel to the line of contact with the alta. * * * In the upper workings the part nearest to the alta is seldom the richest, the cinnabar forming more plentifully at from 5′ to 8′ below the alta, while in the lower workings the richest ore is invariably close to the alta.

"The contact between the alta and the vein-filling is very sharply marked, but there is a gradual change of the above-described vein-filling into the material of the sepentine footwall, the vein material gradually carrying more serpentine, until it has entirely changed into the latter. The hanging-wall is a shale, judging from surface exposures. Underground, no crosscut through the alta to the hanging-wall was seen."

Recent Work.

In the latter part of 1917, some ore was broken in stopes connected with the Day tunnel, which was burned in the coarse-ore furnaces at the Hacienda. A connection was made later on the 800 level, from the Santa Rosa drift near the main shaft, to Deep Gulch Tunnel. This permits of tramming around the hill to the Hacienda furnaces, a distance of about $\frac{1}{2}$ mile, or about one-half that previously traveled for delivery from the Day tunnel. Equipment at the mouth of the Day tunnel includes an Ingersoll-Rand duplex compressor, 16″x14″ and 10″x14″, driven by a 100-h.p. electric motor.

Senator Workings.

The principal ore extraction of recent months has been from the Senator workings, which are, as already stated in a preceding paragraph, nearly 4 miles distant from Mine Hill. This ground adjoins that of the Guadalupe mine, they being on opposite sides of the same ridge. A new 'shaft' (winze) is being sunk, on a 60° incline, starting at 1300′ in from the portal of the main adit. The collar of the old winze is at 1150′ in. An electric hoist with 75-h.p. motor is used. The tunnel level is designated as the 260′ level, and levels down to ♯5 have been established in the winze, with sinking nearing ♯6 level. Only a little sorting is done in the stopes underground. The ore going to the furnaces is stated to vary from 0.2% to 1.0% mercury. The formations and orebodies in the Senator and Enriquita mines are in general similar to those at the southern end of the New Almaden belt, but no bonanza shoots have been found like the massive cinnabar bodies worked in the upper levels of Mine Hill. The Enriquita mine was opened up in 1859, and up to January 1, 1865, had yielded 10,571 flasks of quicksilver. It has not been worked in recent years.

REDUCTION EQUIPMENT.

A study of the development of practices and appliances in the metallurgy of quicksilver during the past 60 years shows the intimate relations of such developments to the history of operations at New Almaden. In the earlier operations, the intermittent form of furnace was utilized. These furnaces and their *modus operandi* are described in detail by Goodyear,[1] who observed them working in 1871 at New

[1]Goodyear, W. A., Examination of the Quicksilver Mines of California: Geol. Surv. of Cal., Geol., vol. II, pp. 106, 119, 131–132, 1882.

Almaden, Knoxville, and New Idria. The most important item for which credit is due to the staff of the New Almaden mine was the development in 1875–1876, of the Hüttner-Scott fine-ore furnace (now generally referred to as the Scott), by H. J. Hüttner, Robert Scott, and J. B. Randol.

For some years, the furnace equipment at the Hacienda (the name given to the community grouped about the reduction plant) included

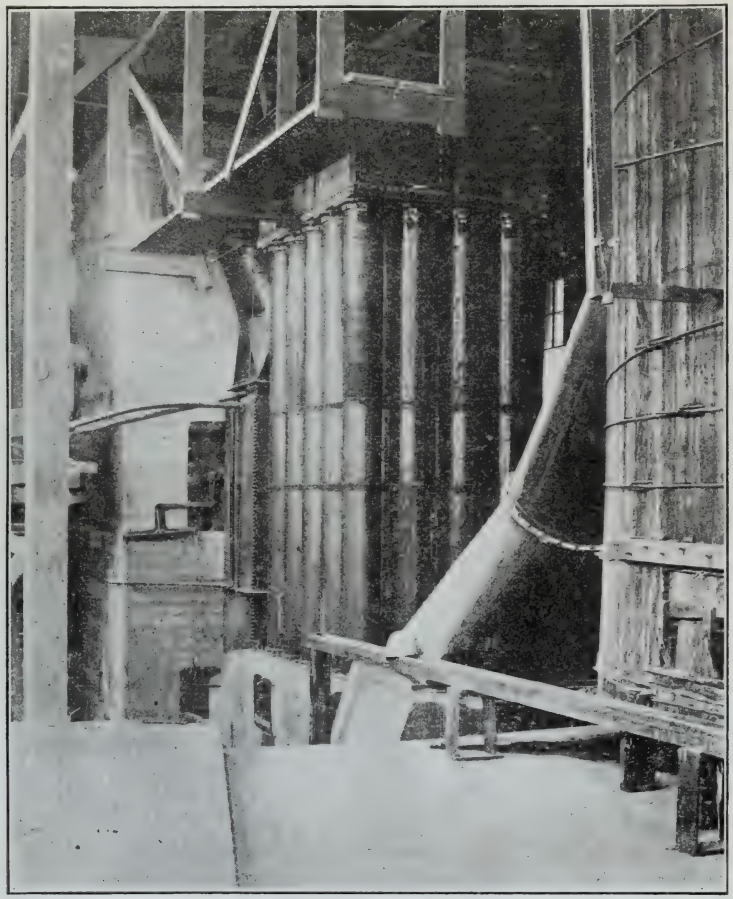


Photo No. 20. Cottrell Dust Precipitator, or 'Hot Treater' (concrete chamber at left), and condensers connected with Herreschoff Furnace, at Senator Mine of New Almaden Company, Santa Clara County. Photo by W. W. Bradley.

two Exeli coarse-ore furnaces of 12 tons capacity each; two Scott furnaces for 'granzita' (medium ore) of 36 tons and 18 tons capacity, respectively; and two Scott furnaces for 'tierras' (fine ore) of 36 tons and 24 tons capacity. In the latter part of 1917, these were all torn down, except the Exelis, and treated for their absorbed quicksilver. The soil and gravel under the site of the old intermittent furnaces and

of the Scotts was excavated to bedrock, a depth of 30 feet, and run through a washing plant for recovery of the metallic quicksilver contained. An important yield of metal was obtained from this material.

At the Senator mine, in 1917, a Herreschoff multiple-hearth furnace, mechanically rabbled, was handling the ore. (See Photo No. 21.) It was installed early in 1916, by the then manager, W. H. Landers, who also, in connection with this installation, patented certain features of the condenser system. This furnace is 14 feet inside diameter and

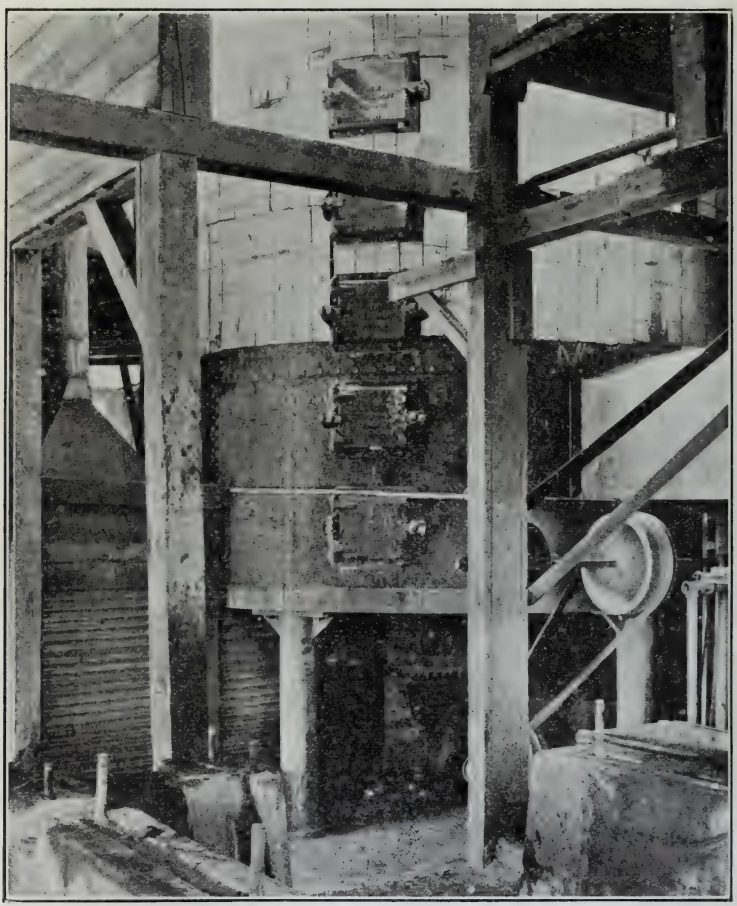


Photo No. 21. Herreschoff Multiple-hearth Furnace at Senator Mine of New Almaden Company, Santa Clara County. Photo by W. W. Bradley.

has 6 hearths, plus a drying floor on the top (see Photo No. 22). There are two fire-boxes on #5 hearth (next to bottom) level, set opposite to each other. On #2 hearth level, about one-third of the way around from the top exit-pipe, a third fire-box has been added in order to keep the temperature of the gases above 600° F. while going through the Cottrell dust precipitator which follows. The central column and the rabble arms are air-cooled, the resulting hot air being utilized for concentrate drying and other purposes. A Brown recording pyrometer

is connected in at the furnace exit to enable regulation of the fume temperature.

This furnace is stated not to work economically on material coarser than $\frac{3}{4}$ inch. Up to 58 tons have been treated in 24 hours; but it seems to do its best work at between 40 and 50 tons. Feeding and discharging are both automatic. The feed hopper is shown in Photo No. 22, while the housing for the discharge may be seen in the lower left-hand corner of Photo No. 23. A steel ore-car is kept under the discharge chute, and when filled is trammed out by hand to the dump.

By reason of the dust raised and thrown into the fume circulation as the ore is mechanically scraped from one hearth to the next, a bother-

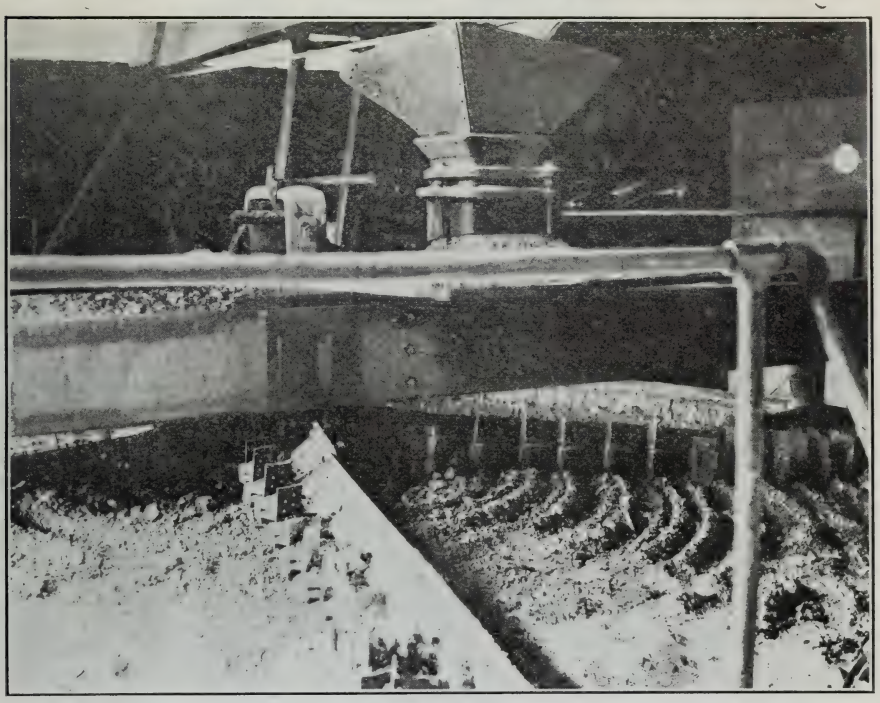


Photo No. 22. Top, or Drying-hearth, of Herreschoff Furnace. Feed hopper is seen in upper part. Photo by W. W. Bradley.

some accumulation of dust was at first obtained in the condensers. To correct this and keep the dust from passing into the condensers, a Cottrell fume precipitator, called the 'hot treater' was installed between the furnace and the first condenser. (See Photo No. 20.) To prevent the mercury from condensing in this treater, the temperature of the gases (as already mentioned) is kept above 600° F. on leaving the furnace. As a precaution to recover any quicksilver which might have condensed in case of irregularities occurring in the furnace operation, the hot-treater dust is run into a settling tank before being discharged to the dump. Following the last condensing chamber is a second Cottrell precipitator (Photo No. 23), called the 'cold treater,' to throw down any remaining mercury 'mist' in the fumes. It is stated that a little quicksilver is obtained in this cold treater. The incoming electric

current of 440 volts is transformed to 50,000 volts for the 'hot treater' and 100,000 volts for the 'cold treater.'

The fuel consumption of this furnace is stated to have proven rather high, being approximately 8 gallons of oil per ton of ore treated, as against 5–6 gallons per ton for a 50-ton Scott furnace. The installation cost of the multiple-hearth type of furnace is much less than it is with the Scott, being stated to be about $20,000 for a 100-ton plant, or $200 per ton-day capacity (1916; but for 1917 nearly double that).

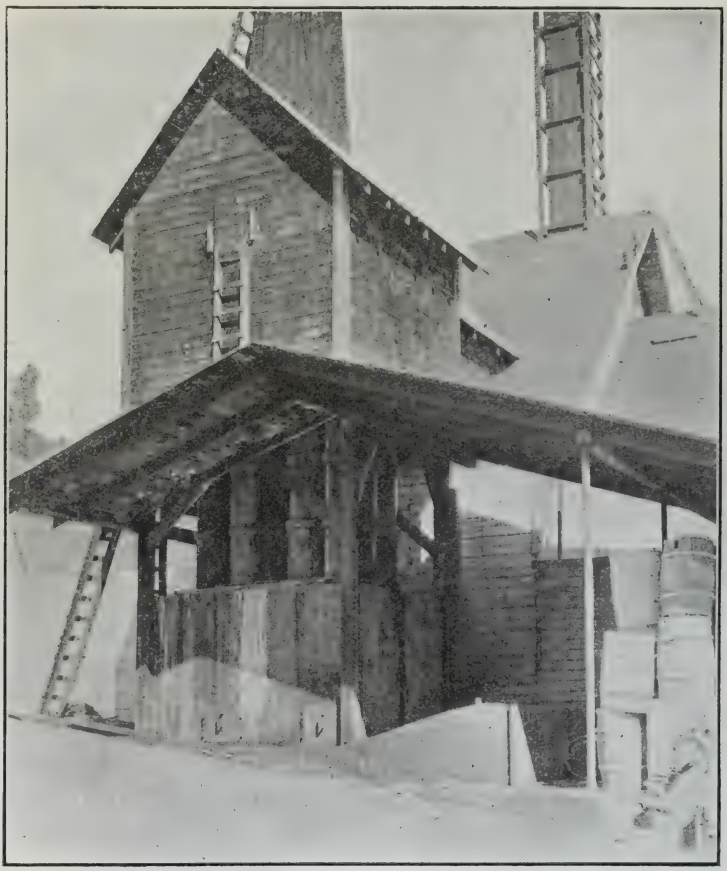


Photo No. 23. Cottrell Precipitator, or 'Cold Treater,' at Senator Mine.
Photo by W. W. Bradley.

The cheapest operation of this type of furnace is obtained with the larger units or with several units under a single roof, as a single machinist can attend to the mechanical features of several units. To repair the rabble arms or other parts of the interior mechanism, the furnace must be shut down and cooled off. This is apt to occur oftener than interior repairs are required in a Scott furnace, though Herreschoff units have been in operation on copper ores for more than two years without such repairs. It is stated that an 82% recovery of the assay value of the feed was obtained with the Herreschoff furnace for

the 4 months ending with July, 1917.. The heads assayed approximately 0.9% mercury, and contained from 3 to 5 tons, daily, of concentrates assaying up to 4%, which were mixed with the mine-run ore.

As the furnace does not work economically on material coarser than ¾″, the ore after preliminary breaking in a gyratory crusher, is passed over a shaking screen of ¾″ mesh, and the oversize re-crushed in a jaw breaker. A bucket elevator is included in the equipment, and electric power is used. The first condenser consists of 20 iron pipes 12″ diam. x 12′ long, an arrangement patented by Landers[1] in 1916, then manager of the New Alamaden Company. Condensers ♯2, ♯3, and ♯4 are redwood-stave tanks, 12′ diam. x 16′ high. No. 2 can be seen at the right of the photograph. These tanks are cleaned out one a week.

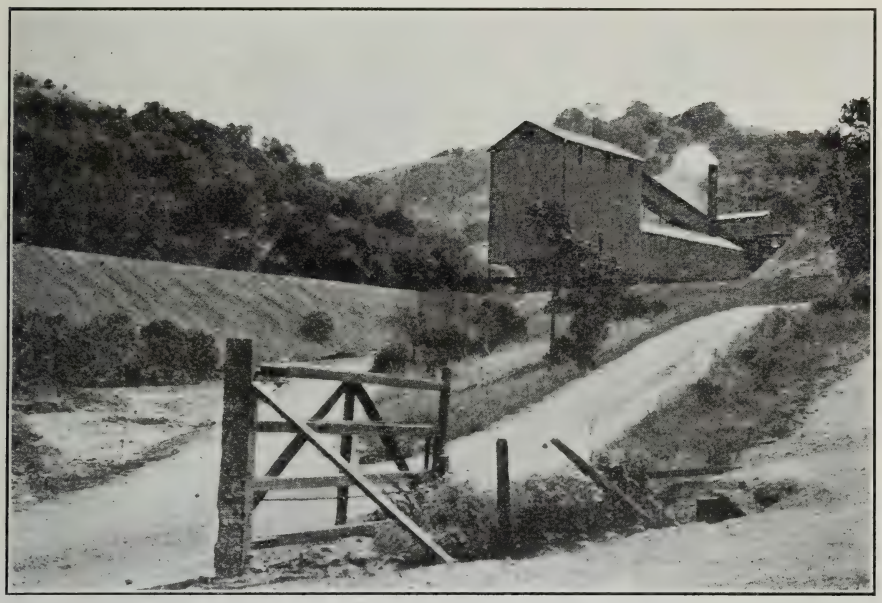


Photo No. 24. New 90-ton Scott furnace at Senator Mine of New Alamaden Company. Photo by W. W. Bradley.

A 90-ton double Scott fine-ore furnace was built in the early part of 1918. It has 4 fireboxes and handles a minimum of 75 tons per day, though it has treated up to 96 tons per 24 hours. It is thus the largest Scott furnace at present in operation. The ore is crushed to pass a 2-inch ring; and is transported from the crusher bins, by an inclined belt-conveyor, discharging directly into the top of the furnace. The side walls of the furnace are built up several feet above the level of the throat, thus giving an auxiliary ore-bin and providing an automatic furnace-feed.

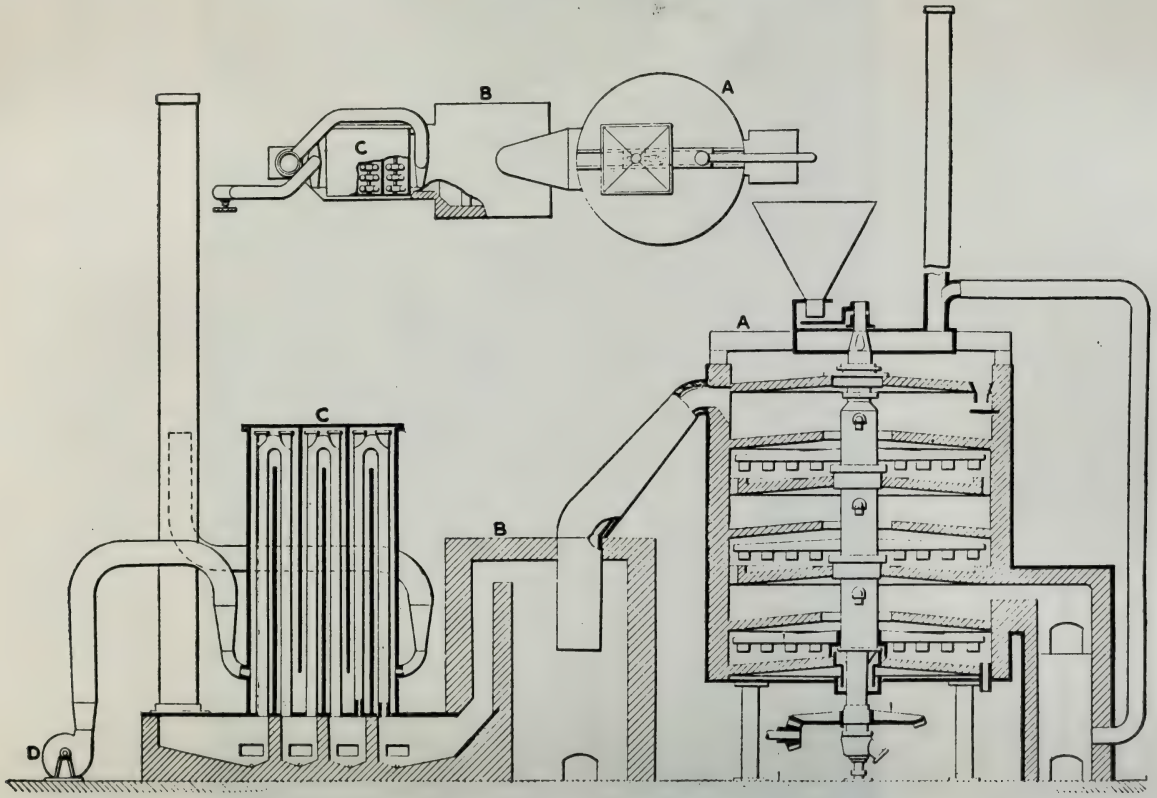
There are eight new condensing chambers connected with this furnace, arranged in a double row. The first chamber in each row is of concrete, and the other three are of tongue and groove redwood, built rectangular. A 3-foot redwood-stave flue connects the last of this series of condensers to the first circular wooden condenser of the Herreschoff series. Crude oil is used for fuel.

Concentration.

Both table concentration and flotation were tried in 1916-1917, but were discontinued in September, 1917. In June, 1916, a concentration

[1]Landers, W. H., The smelting of mercury ores: Eng. & Min. Jour., vol. 102, p. 634, Oct. 7, 1916.

PLATE III.



Plan and Sectional Views of the "Landers Mercury-Smelting Furnace."

plant consisting of a ball-mill and a Deister-Overstrom table was in operation at the old Randol dump, but later moved to another part of the property, as the quicksilver values in the dump material were spotted and too low for commercial work. On June 15th, with the plant running smoothly and apparently doing good work, samples taken every half-hour for 5 hours assayed as follows: Heads 0.03% mercury; tails 0.015%; middlings 0.03%; concentrates 1.16%. The ore treated in the 5 hours amounted to 20 cars of 15½ cu. ft. each. There was occasionally a very little native quicksilver, which was caught by amalgamation on a piece of tin at the concentrate-discharge end of the table.

Photo No. 25. Flotation Concentrates drying in the sun, at the Senator Mine of New Almaden Company, Santa Clara County. Photo by W. W. Bradley.

Following that, concentration plants were placed in operation at the Day tunnel and at the Senator mine which is at the north end of the New Almaden property. These plants consisted of crushers, ball-mills and Deister-Overstrom tables. The concentrates were roasted and mixed with ore, in the Herreschoff furnace installed at the Senator. Electric motors furnished the power. In the Day tunnel mill, below the jaw crusher was a 6′ x 5′ Allis-Chalmers ball-mill in closed circuit with a Dorr Simplex classifier. The grinding was regulated so that approximately 87% of the pulp passed 60 mesh. The overflow from the classifier passed through 4 Callow flotation cells, and then to 1 double-deck Deister-Overstrom table. The table was not only crowded (120 tons per 24 hr.) but was compelled to handle an unclassified feed. A 12′ diam. x 6′ high, Dorr settler dewatered the concentrates, followed

by a 6′ diam. x 4′ Oliver filter. The concentrates were handled by motor truck to the Herreschoff furnace. It is stated that the heads sample averaged 0.23% mercury; that the tailings could have been brought down to 0.03% mercury by finer grinding; that the equipment and practice could have been improved so that an extraction of over 80% could have been obtained; but that it cost from $80-$85 per flask (including furnace reduction of the concentrates) to produce the metal, as against $45-$50 per flask by careful sorting and regulation of the ore feeding direct to the furnace. Fine grinding was the expensive part of the process. The ore being largely a hard and tough, silicified serpentine, the steel-liner and ball consumption was high.

Photo No. 26. Gravel-washing plant for recovering metallic quicksilver from material excavated from old furnace sites, at Hacienda of New Almaden Company, Santa Clara County. Photo by W. W. Bradley.

There is no ochre in the ore, but considerable slime from the serpentine. Screen analyses showed cinnabar in the flotation tailings on the — 80 and — 100-mesh 'chats'.

The flotation plant at the Senator had 3 Callow cells and a Deister-Overstrom table; and at first used two 4′ x 4′ ball-mills. These latter were replaced by a 4½′ x 6′ Marcy mill. The flotation concentrates proved to be messy stuff to handle, and not the easiest thing to dry for convenient feeding to the furnace. According to R. S. Lewis[1] others have found the handling of flotation concentrates far from being an 'unalloyed pleasure.' After passing through the flotation cell, the pulp passed directly to the tables without further classification or

[1]Lewis, R. S., The disposal of flotation products: Min. and Sci. Press, Vol. 114, pp. 473–484, April 7, 1917.

dewatering. Some experiments were tried with dewatering at the Senator plant, but with only slight success, it is stated.

As mentioned above the ground underneath the site of the old intermittent adobe furnaces, and of two of the older Scott furnaces and their condensers, was excavated to bedrock, a depth of 25′ to 30′. This earth, sand and gravel was well-sprinkled and disseminated globules of quicksilver, which had worked their way down from the furnaces during the years of operation here. The material is hoisted and transported by an Alaska-carrier cable, having a bucket of 1 ton capacity. From 50 to 100 buckets per day are hoisted, the men working on a bonus system. The bucket dumps into a bin (see Photo 26) from which the material is fed to a revolving screen with $\frac{3}{4}$-inch round holes. The $-\frac{3}{4}''$ material then passes to a 'log washer' (having a screw conveyor); then, successively, through a riffled launder; a Richards pulsator-riffle (Hungarian riffles with a pulsator compartment); and finally through another riffled launder. This has proved to be quite an effective plant for the material being handled. Even the bin at the head had to be made mercury tight with provision for drawing it off as considerable quicksilver settles out there when the bucket is dumped. The larger boulders are handsorted out, in the pit, and dumped to one side of the washing plant.

Timber, Labor, etc.

There is little or no mining timber available in the vicinity of these mines. Sawed timber is brought in by the railroad from outside points. Fuel oil is used at the furnaces. In September, 1917, a total of 105 men were employed, including 60 underground, and 6 at the Senator furnace plant.

Bibl.: [Note—The New Almaden mine and plant have been described by so many writers, that only the principal references are here given. Others will be found in the Bibliography in Part III, of this bulletin.] Cal. State Min. Bur. Repts. 1, pp. 26, 27; IV, pp. 336 et al; VIII, pp. 541–542; X, pp. 604–606; XI, pp. 374–375; XII, pp. 367–370; XIII, pp. 600–601; Bull. 27, pp. 174–186; Bull. 78, pp. 160 et al. U. S. G. S., Mon. XIII, pp. 8, 310–330, 467; Bull. 78, pp. 80–83; Min. Res. 1883–1915 inc. Mining Resources West of Rocky Mountains, 1867, pp. 170-178; 1874, pp. 33, 380, 540; 1875, p. 13; 1876, pp. 4–18, 20. Min. and Sci. Press, vol. 84, pp. 393–404, 1902; vol. 87, p. 201, 1903; vol. 100, pp. 15–16, 446–447; Feb. 16, 1916, pp. 282–284. Eng. and Min. Jour., Vol. 34, pp. 185–186, 334, 1882; Vol. 91, p. 85, 1911; vol. 102, p. 630, 1916. Geol. Surv. of Cal., Geol. Vol. I, p. 68; vol. II, pp. 91–110, 122.

Santa Teresa Mine. Enos Fontis, of Edenvale, owner. This property is 8 miles southeast of San Jose on the east slope of the Santa Teresa Hills. It was developed by the Santa Teresa Quicksilver Mining Company, of which R. H. Harper of San Jose was superintendent. A 40-ton Scott furnace was erected, and several tunnels driven into the hill to cut the vein. The country rock is serpentine, and the ledge matter an alteration product of serpentine through silicification, carrying a low percentage of cinnabar. After working a few years, without

encountering any orebodies of sufficient size or richness to warrant their further exploitation, the mine was abandoned; and is still idle.

Bibl.: Cal. State Min. Bur. Bull. 27, p. 186; Chapter Rept. Bien. period, 1917–1918, in preparation.

Silver Creek Mine (North Almaden). A. R. Bradford et al., owners, 770 East St. John street, San Jose. This property, formerly known as the North Almaden mine, is 12 miles by road southeast of San Jose, on the east side of Silver Creek. A large body of serpentine containing cinnabar was found in Silver Creek gulch, overlying Knoxville gravels. This detached body was evidently due to a great landslide which is plainly visible about the works. It was approximately 1000′ in length, 300′ wide, 60′ in thickness, and was exhausted in a few years, producing about $60,000 worth of quicksilver. Occasional prospecting has been carried on since, but no important ledge has been found in place. The property is equipped with a 20-ton Scott furnace and a pipe retort.

Bibl.: Cal. State Min. Bur. Repts. XII, p. 367; XIII, p. 600; Bull. 27, pp. 187, 235, 238; Chapter Rept. Bien. period, 1917–1918, in preparation.

Wright Mine. Mrs. A. Rodgers, owner, San Francisco. It is 3 miles south of the New Almaden Hacienda, on Llagas Creek, and is said to have produced some high-grade ore many years ago. It is hardly more than a prospect, and has had but little development work done on it. Idle.

Bibl.: Cal. State Min. Bur. Repts. XII, p. 370; XIII, p. 600; Bull. 27, p. 187; Chapter Rept. Bien. period, 1917–1918, in preparation.

SANDSTONE.

An extensive body of hard buff-colored sandstone, which is deposited in beds varying from a few inches to several feet in thickness, occurs at Graystone Station, 9 miles south of San Jose, on the Almaden branch of the Southern Pacific Railroad. This stone was formerly quarried for building purposes in San Francisco, San Jose and other towns, and it was used for the construction of the buildings of Stanford University. There has been no stone cut from this deposit for several years, and the only sandstone quarries now operated in the county are those producing crushed rock, described under the heading, "Stone Industry."

Bibl.: Repts. VIII, p. 547; X, p. 618; XII, p. 399; XIII, p. 637; Bull. 38, pp. 133–138.

STONE INDUSTRY.

Alum Rock Quarry. A deposit of siliceous shale occurs in Alum Rock Cañon a few hundred yards above the end of the car line. This rock is occasionally quarried for local road uses by the City of San Jose. The quarry was idle at the time visited.

Bibl.: Bull. 38, p. 223.

Campbell Gravel Plant. The E. B. and A. L. Stone Company, Rialto Building, San Francisco, owns a bed of gravel and sand in Los Gatos Creek, 1 mile south of Campbell, alongside of the Peninsula Railroad.

The plant was erected in 1912, and was in continuous operation up to the first part of 1919, when it was closed down, due to lack of construction work. The deposit is said to be at least 80 feet in depth and is inexhaustible, as the pits dug in the bed during the year are refilled with gravel and sand in the wet seasons by the swollen creek. The material is mined by a slack line scraper which hauls it to the plant alongside of the creek. Here it is dumped onto a grizzly, the over-size going to a Sturtevant mill, while the under-size is passed through a series of revolving screens and washed. The washed and sized products are then stored in bins, from which they are loaded directly onto trucks, or railroad cars. The water for washing purposes is obtained from a well at the property, and as there is a scarcity, after washing it is returned to settling tanks and re-used. The plant is operated by electric power supplied by the Pacific Gas and Electric Company. The daily capacity of the plant is 300 tons. E. U. Leh, district superintendent for the company, is in charge of this and the Coyote plant.

Coyote Gravel Plant. This plant, erected by the E. B. and A. L. Stone Company, in 1913, is on Coyote Creek, ½ mile south of Coyote Station. A spur track of the Southern Pacific Railroad is laid to the property, which covers 15 acres. The gravel bed here is a few hundred feet wide and about 12 feet thick. It is mined by a 70-ton oil burning Bucyrus steam shovel and hauled to the plant by an electric motor train operated by a 3d rail conductor. The plant, equipped with a gyratory crusher, trommels, elevators, washing vats, etc., has a daily capacity of 1000 tons, and is operated by electric power. Sufficient water for all purposes is supplied by a well sunk in the creek. Sixteen men are employed when the plant is operated at full capacity. For several months (last part of 1918 and first part of 1919) the plant has been operating at only part capacity.

Hillsdale Quarry, also known as the **Gay Quarry**, is near Hillsdale Station, 3 miles south of San Jose, at the northern end of the San Juan Hills. The rock is a fine-grained, hard, metamorphosed sandstone, fractured and traversed by clay seams and was formerly quarried for macadam and concrete uses. The machinery has been removed and the land is now used as pasture. Formerly owned by the Security Savings Bank of San Jose, but recently sold to John E. Anderson.

Bibl.: Repts. XII, p. 399; XIII, p. 626; Bull. 38, p. 324.

Quality Sand and Rock Company, formerly known as the **Saratoga Crushed Rock Company.** G. W. C. Baker, president; Wm. T. Macdonald, secretary; office 903 First National Bank Building, San Jose. This company owns and operates a quarry situated in Campbell Creek Cañon, one mile west of Saratoga, just below Congress Springs. The rock is a hard, gray, metamorphosed sandstone, approaching a quartzite, which has been greatly shattered, so that it breaks up readily in small angular fragments. The deposit is approximately 700 feet thick and covers many acres. A bench is now being quarried 300 feet above the road. The rock is loosened by blasting and then quarried by steam shovel, which loads into cars hauled by electric power to the crushing plant. Here it is passed through the usual equipment, consisting of a gyratory crusher, trommels, belt conveyors, washing vats, etc. The crushed and washed products are then conveyed to the storage dump

below the plant. Two concrete lined tunnels 387′ and 115′ in length, respectively, have been driven into the hill under the dump and above the loading bins that are placed alongside of a spur track of the Peninsula Railroad. These are equipped with belt conveyors, and steel doors placed at intervals along the tops of the tunnels, through which the crushed rock is drawn and conveyed to the loading bins. Besides crushed rock, a siliceous sand is produced which is said to be excellent for concrete and plaster use. The entire plant is operated by electric power supplied by the Pacific Gas and Electric Company. Twenty men are employed, producing 450 cu. yds. of crushed rock daily. Chas. C. Bell is superintendent at the plant, which has been in operation since 1908.

Stanfield and Knowles Quarry. This quarry adjoins that of the Saratoga Crushed Rock Company, 1 mile west of Saratoga, on a precipitous hillside, being a continuation of the same hard metamorphosed sandstone. The rock is loosened by blasting, and hauled to the plant alongside of the road by a drag line scraper. Here the rock is crushed, sized and stored in the loading bins, from which it may be drawn into cars or trucks. Electric power is used. The quarry has been worked for the past twelve years. Three men are employed. Owners, Jim Stanfield and Dr. Knowles, of Los Gatos.

Stanford Quarry. A deposit of basalt which outcrops on the Stanford Estate, one mile back of the university, is quarried to supply crushed rock for macadam and building purposes about the university. Some of the rock is sold to contractors, principally for road use, the balance being used locally at the university. The basalt flow covers many acres, and the quarry is a circular cut, a couple of hundred feet in diameter with a face 100 feet in height. It is equipped with a crushing plant, consisting of a No. 5 gyratory crusher, trommel, bucket elevator, small jaw crusher. Two electric motors of 40-h.p. and 20-h.p., respectively, are used to operate the plant. Twenty-five men are employed. J. E. Hewsted is general superintendent, and F. Capperman is in charge of the quarry, which is operated by the university authorities.

SANTA CRUZ COUNTY.

By E. Huguenin and W. O. Castello.

(Field work in 1919.)

Santa Cruz County, created February 18, 1850, is one of the original twenty-seven counties of the state. Its name, signifying "Holy Cross" was derived from the cross which marked the site of the mission which was founded upon its shores by Padres Lopez and Salzar. This county, consists of 7437 square miles, and has a coast line of about 40 miles. San Mateo and Santa Clara counties are on its north, Santa Clara on its east with Monterey adjoining it on the south.

The city of Santa Cruz, the county seat, lies along the north shore of Monterey Bay, and is one of the most attractive seaside resorts of California, boasting of a fine bathing beach, combined with a delightfully equable climate, within easy access of San Francisco by rail or highway.

Watsonville, located along the Pajaro River, which forms the southern boundary of the county, is second in size, with a population of approximately 7000 and is a thoroughly modern town, being the shipping center of the fertile Pajaro Valley.

TRANSPORTATION.

The county is readily accessible as it is traversed by a line of the Southern Pacific Railroad from San Jose via Los Gatos to Santa Cruz, having a branch line at Felton which follows the San Lorenzo River northward.

Another line of the same company follows the coast southwestward from Santa Cruz to Watsonville, connecting with the main line at Watsonville Junction two miles eastward. A branch line also follows the coast from Santa Cruz northward to the plant of the Santa Cruz Portland Cement Company at Davenport. A municipal pier constructed at a cost of over $100,000 allows docking of deep sea ships. Several highways make the county readily accessible to the motorist.

TOPOGRAPHY AND GEOLOGY.

The geology of the greater portion of the county has been described in detail by J. C. Branner, J. F. Newsom, and Ralph Arnold, in the Santa Cruz Folio, No. 163, issued by the U. S. G. S., from which the following general description is taken, and to which the reader is referred for greater detail:

The curving shore line of the Pacific Ocean and Monterey Bay and the corresponding curve of the Castle Rock Ridge, which forms the eastern boundary of the county, enclose an irregular crescent-shaped area averaging 20 miles in width, and of fairly mountainous character, the general trend of the ridges being northwest and southeast. The main ridge is the Castle Rock Ridge, which consists essentially of heavy bedded sandstones and Monterey shales. It rises to elevations of over 3000 ft. and forms an escarpment with a steep northeastern slope bordered by the line of valleys lying along the San Andreas fault line. Ben Lomond Mountain, which lies between Castle Rock Ridge and the ocean, running parallel to the main ridge, has been formed by the

upward tilting of a granite block along the Ben Lomond fault, forming a mountain with a steep escarpment towards the northeast and a long gentle slope along the southwest, which extends to the ocean.

The hillsides are generally steep, covered with a deep coating of soil, and cliffs are rarely found on them. Away from the ocean the hills are densely wooded, and in the region of the San Lorenzo River are several redwood groves containing trees of gigantic size.

The Monterey shale areas which cover the greater portion of the county are characterized by steep, narrow, V-shaped cañons and high ridges with steep slopes, while the massive sandstone beds of the Vaqueros formation generally produce a comparatively rugged topography. Filled U-shaped valleys are developed in many places along the sea coast, as are well-developed sea terraces. Isolated patches of micaceous schist and highly crystalline white limestones occur lying above the granite core of Ben Lomond Mountain northwest of Santa Cruz and west of Felton. They have been broken and shattered by the intrusion of the granite, and appear from their extreme metamorphism to be older than the Franciscan formations.

DRAINAGE AND WATER SUPPLY.

The main drainage system of the county is that of the San Lorenzo River, which rises in the Castle Rock Ridge and flows southeastward along its base, draining the eastern slopes of Ben Lomond Mountain and emptying into the sea at Santa Cruz. It drains an area of 126 square miles, almost one-third of the territory of the entire county. The Pajaro River drains the southern portion of the county, flowing in general westward and entering Monterey Bay at the southern boundary of the county. Numerous small perennial streams flow from the west side of Ben Lomond Mountain to the sea. These streams have cut back rapidly into the soft sediments which form the western slopes, so that the lower parts of their channels are fairly well graded.

Santa Cruz has but a few small springs and is dependent upon the numerous perennial streams for its water supply. The region drained by the headwaters of the San Felipe River, as well as the coastal region, is kept moist during the dry season by dense fogs which drift from the sea up the valleys. In the winter and spring heavy rainfall occurs. This rainfall, combined with the summer fogs common to that region, made possible the dense growth of redwoods that formerly covered most of that country, but few of which remain.

MINERAL RESOURCES.

By referring to the table of mineral production of Santa Cruz County it will be seen that while the production is fairly large, amounting to a total of $18,436,088 for the period from 1894 to 1918, inclusive, the variety of minerals produced has been very small, and practically confined to the structural materials, bituminous rock, cement (which is included under unapportioned so as to conceal the output of the individual producer), clay, lime, and stone (which includes crushed rock, sand, and gravel). A fairly large production of limestone for commercial purposes is also reported. Minerals that are known to occur in the county other than those listed in the table are coal, gold, iron, mineral water, petroleum, and silver. The production, in order of its value to date, is: cement, lime, bituminous rock, limestone, stone industry and

those combined under "miscellaneous," including asphalt, brick, clay, and granite. There are no segregated, county figures available earlier than 1894.

ASPHALT AND BITUMINOUS ROCK.

The bituminous rock deposits of Santa Cruz County have long been known. The name "bituminous rock" is rather misleading, as the material is a porous, loose, fine to fairly coarse-grained sandstone impregnated with asphaltum. The most important and only deposits worked in recent years of this so-called bituminous rock are those of the City Street Improvement Company described below, located in the west slopes of Ben Lomond Mountain, approximately five miles in an air line northwest of Santa Cruz. Quoting from the U. S. G. S., Santa Cruz Folio, "The bituminous rocks are sandstone beds lying near the base of the diatomaceous shale, which is referred to the Monterey. Most of the sandstone beds which immediately underlie or are intercalated with the diatomaceous shale of this locality are more or less bituminous. The structure is monoclinal, with a gentle southwest dip, hence the asphalt-bearing strata crop out along the sides of the southwestward-flowing streams where these have cut down nearly or quite to the bottom of the shale.

The zone of the bituminous rock is exposed near the base of the diatomaceous shale from Santa Cruz northwestward as far as the western side of the Big Basin, a distance of more than 20 miles. Throughout this distance the dip of the lower part of the diatomaceous shale and of the immediately underlying sandstone is gently to the west and southwest. At many places through this district the sandstone beds are more or less bituminous, but at only one locality have they been found to be of commercial value.

Bibl.: U. S. G. S. 22nd An. Rept., Part I. pp. 383-405; Geological Folio 163.

Cowell Mine. This deposit of bituminous sandstone is situated 8 miles by road northwest of Santa Cruz and ½ mile east of the City Street Improvement Company's mine. There is no road connection between the two, so that when working it is necessary to haul the material by road to Santa Cruz. The bituminous sandstone bed here varies from 12′ to 20′ in thickness and is overlain by a heavy bed of the diatomaceous shale. The bed has been exposed by several open cuts, each of several hundred feet in length. It is worked occasionally in a small way for local use. Owner, Henry Cowell Lime and Cement Company, 2 Market street, San Francisco.

Bibl.: Repts. X, p. 621; XII, p. 28; XIII, p. 44. U. S. G. S. 22nd An. Rept., Part I, pp. 399-404.

Santa Cruz Bituminous Rock Mines (formerly the **Walrath Mines**) are also known as the **Pacific Improvement Company's Mines.** This deposit has been worked for over thirty years, and is situated at an elevation of from 800′ to 900′ above sea level. There are three distinct layers of the bituminous sands, which lie fairly flat. The lower bed or strata is about 7′ thick and has not been developed to any extent, as the work has been confined to the upper and heavier beds. Above the lower bed is a layer of sand 8′ thick containing a low percentage of bitumen.

Table of Mineral Production of Santa Cruz County—1894 to 1919, Inclusive.

	Lime		Limestone		Bituminous rock		Stone	Miscellaneous and unapportioned	
1894	167,000	138,200	4,000	5,000	20,782	79,980			
1895	145,000	133,750	12,055	12,055	32,067	102,486	4,000	75 M brick	375
1896	116,000	95,500	27,827	28,633	43,843	109,536	4,000	497 M brick	2,485
1897	149,600	111,800	10,688	8,005	43.179	123,056		300 M brick	1,500
1898	151,000	151,000	7,912	5,738	40,598	113,898			
1899	161,893	176,893	4,135	3,730	27,503	70,569	200		
1900	163,965	131,288	1,669	1,213	21.960	58,590			
1901	161,500	161,500	3,845	3,595	13,580	30,654		10 tons clay	30
1902	185,223	161,302	1,850	1,850	31,700	41,084		106 tons asphalt	1,060
1903	220,835	185,442	3,000	2,725	18,426	45,190	20,750	700 cubic feet granite	140
1904	293,207	306,775	[1]	[1]	[1]	[1]	2,925		
1905	218,084	199,974	7,325	52,125	17.583	42.500	1,750		
1906	255,469	347,490	11,431	55,242	13,544	38,860	3,500		
1907	213,599	241,179	6,370	6,000	21.955	64,707	14 800		
								470 cubic feet granite	336
1908	119,996	119,996	1,178	2,167	25,041	85,123	19,736	28,400 tons clay	28,400
								63,541 tons clay	13,800
1909	228,875	296,785	3,457	5,273	31,392	110,067	20,717	Unapportioned, 1900-1909	1,794,294
								52,976 tons clay	15,981
1910	214,137	230,513	4,361	6,770	35,565	124,195	23,425	Unapportioned	2,096,031
1911	216,508	206,225	22,622	44,591	24,815	80,371	7,627	Unapportioned	2,448,339
1912	169,646	159,505	7,507	7,553	32 146	80,439	22,710		879,437
1913	75,000	60,000	39,494	30,994	26,932	67,330	10,511	Apportioned	1,647,970
1914	173,282	157,011	14,666	25,082	40,540	115,500	4,276	Unapportioned	1,341,089
1915	191,643	177,873	2,047	4,873	17,399	60,728	6,794	Unapportioned	1,331,263
1916	176,263	225,485	4,318	9,820			2,815	Other minerals[2]	1,440,991
1917				185,156			2,368	Other minerals[3]	1,480,800
1918	182,083	285,316	7,132	15,313			9,107	Other minerals[4]	2,599,717
1919	150,271	234,039	5,527	12,690			17,074	Other minerals	1,981,253

Bituminous rock	$2,225,333
Lime	4,460,882
Limestone	733,462
Stone industry	179,085
Miscellaneous and unapportioned	19,105,201
Total	$26,703,993

[1]Included in unapportioned 1900-1909.
[2]Cement, marble and bituminous rock.
[3]Cement, potash and bituminous rock.
[4]Cement, potash and bituminous rock.

Above this is the middle bed, which is a rather coarse-grained sandstone averaging 30′ thick, and containing from 10% to 14% aspahlt. Upon this rests a bed of diatomaceous shale which varies from 50′ to 60′ in thickness. Above this lies the top strata, a fine-grained, hard, bituminous sandstone carrying from 14% to 18% asphalt and varying from 6′ to 22′ in thickness. These beds have been exposed by open cuts for over a thousand feet and may be traced for a couple of thousand feet. It has been estimated that the deposit will yield several million tons before being exhausted.

The material was formerly mined by removing the shale capping by blasting and a drag line scraper, then augurs were used to bore holes through the bituminous bed. The holes were blasted by using one-half pound of dynamite to spring the bottom of the hole for the blast, for each keg of powder. Seven kegs of powder, containing 25 pounds each, was the usual charge. Large blocks were dynamited and broken into small pieces, which were loaded by hand into three-ton skips. The skips were in turn lifted by means of two 80′ guy derricks onto trailers which were hauled three miles to the railroad by a steam tractor, hauling 40 to 50 tons per load. A stiff-leg derrick at Godola, the railroad station, was used to empty the material from the skips onto the flat cars for transportation. Oil burning donkey engines were used to operate the derricks. The water used was pumped from a spring several hundred feet below the quarries by means of two large overshot water wheels. An average of 20 men were employed during nine months of the year.

During the recent war period, the quarry was worked only occasionally, about 2000 tons being sold to the United Railroads of San Francisco and, more recently, several hundred tons, to the City of Santa Cruz. This material was hauled by auto trucks, out of the face of the quarry, without disturbing the overburden.

The material is prepared for road use by mixing, into the proper proportion of sand, stone dust, and such other materials as are necessary, in a Torpedo mixer, which is a revolving conical shaped drum, heated by oil, and mounted on a conveyance, so that it can be hauled to the location at which the road work is being done. The excellency of this material for road and street work is demonstrated by several streets in San Francisco, which were laid over 20 years ago and are still in excellent condition. The enormous amount of this bituminous sandstone so readily accessible should be a great factor in the building of good roads in California.

Owner, City Street Improvement Company, 166 Geary street, San Francisco, J. H. Bishop, manager; W. E. Flannagan, resident superintendent at Santa Cruz.

Bibl.: Repts. XII, p. 28; XIII, p. 43. U. S. G. S. 22d Annual Report, Part I, pp. 384-394; Santa Cruz Folio Cal. Journal of Technology, August, 1913.

Thurber's Quarry. This deposit is north of and adjoining the City Street Improvement Company at 950′ elevation. The bed of bituminous sandstone here varies from 10′ to 30′ thick and has not been extensively developed. Some work was done several years ago, but it has lain idle since. The material is said to be not as uniform as that of the adjoining deposit and comparatively little of the bitu-

minous rock has been utilized. Owner, Consolidated Bituminous Rock Company, Nevada Bank Building, San Francisco.

Bibl.: Repts. VII, p. 96; VIII, p. 554; XII, p. 29; XIII, p. 44. U. S. G. S. 22d An. Rept., Part I, pp. 393-396.

CEMENT.

Santa Cruz Portland Cement Company. The manufacture of cement in Santa Cruz County began with the operation of this company's plant in 1907, since which time it has been the largest producer in California, although not working up to full capacity. The plant is situated on the coast at Davenport, 13 miles northwest of Santa Cruz, on both the Southern Pacific and Ocean Shore railroads. The quarry from which the limestone is taken for the manufacture of the cement is 3 miles northeast of the plant along the northwest side of the San Felipe Cañon. The present quarry face at the highest point is at least 500′ high and it has been opened by a semicircular cut, several hundred feet in diameter. The stone is coarsely crystalline, white to blue limestone, similar to that at other quarries in the county. It is shattered and broken and traversed by seams of clay. It comes from the quarry in huge irregular blocks, which are broken by blasting into pieces sufficiently small to enter the No. 9 gyratory crusher installed at the reserve bins below the quarry. The stone is quarried by driving a short tunnel, with air drills, and drifting across the face, forming a T. This is loaded with dynamite and the whole face caved, bringing down thousands of tons at one charge. The broken rock is loaded into 3-ton steel cars, and trammed to the large storage bins, where it is put through the crusher. From the bins the limestone is drawn into 20-ton side dump cars and hauled by a steam locomotive over a standard gauge railroad, owned by the company, to the plant at Davenport. Eight cars are hauled per trip, making a trip every hour. The clay required is shipped in from the company's clay bank at Glenwood, a station on the Southern Pacific in the Castle Rock Ridge Mountains, where it is mined by steam shovel.

The following description of Portland cement and its manufacture is given for the benefit of those who are not familiar with it:

[1]"Portland cement was invented by Joseph Aspdin of Leeds, England, and was thus named from its fancied resemblance, when set, to the well known oölitic limestone of Jurassic age quarried for building purposes on Portland Isle, Dorsetshire, England. Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate mixture of properly proportioned argillaceous and calcareous substances, with only such additions subsequent to calcining as may be necessary to control certain properties. Such additions shall not exceed three (3%) per cent of weight of the calcined product. Chemically, Portland cement is a combination consisting principally of silicates and aluminates of lime, and the raw materials must necessarily contain silica, alumina, and lime.

"The first process in the manufacture of Portland cement is the mixing of raw materials. In order that this mixture may be uniform

[1]U. S. G. S., Mineral Resources, 1914, Part II, pp. 222–223.

and homogenous and the respective ingredients properly proportioned, they must be reduced to a fine powder. * * * ''

At the plant of the Santa Cruz Portland Cement Company the limestone hauled from the quarry is dumped into bins from which it is passed through two No. 6 gyratory crushers and by belt conveyor to oil-fed rotary driers. The dried product is then conveyed to the ball mill bins and into a set of ball mills, where it is reduced to the size of sand grains. It is sampled automatically and the percentage of the constituents determined. The clay which is stored in bins along the railroad track by means of a steam shovel is drawn out of the bins into 5-ton cars and hauled by cable to a bin from which it is conveyed to a rotary drier and in turn to a separate set of ball mills. The clay is also automatically sampled, and to every 1000 lbs. of the limestone from the ball mills is automatically added the necessary weight of the clay to give the required mixture. This mixture is effected in a double screw conveyor which introduces the material to the tube mills for grinding, where a thorough mixture is obtained. The raw mixture before burning is made up approximately as follows: 75% lime carbonate, 20% silica, alumina and iron oxide, 5% impurities, which include magnesia, sulphur and some alkalies. The mixture is next conveyed to the 125-ft. rotary oil-burning kilns, where it is heated to incipient fusion, the resultant clinker being grayish or bluish black in color. The clinker is dropped into pits below the kilns from which it is drawn out in cars to the yard. It is dumped on the storage pile in yard ($\frac{1}{2}$ million tons capacity) by means of an electrically operated aerial tramway suspended between two high steel towers. A series of concrete tunnels equipped with belt conveyors, below the storage clinker dump conveys the clinker to a series of Williams pulverizers and tube mills for the final grinding, gypsum up to 2% being added just before the final grinding. Extreme fineness of grinding is very essential for a good Portland cement, and of the finished product 90% to 95% will pass 100 mesh, and 75% to 85% through 200 mesh.

The plant is equipped with 12 ball mills, 24 tube mills, and 24 125′ kilns of which only 14 are in use. The total capacity of the plant is 12,000 bbls. daily. The present output is 8000 bbls. Electric power is used throughout the plant and at the quarry to operate the compressors, tramway, crusher, etc. From 350 to 500 men are employed depending upon the output. Fred Davis is in charge of the plant. This company also operates the cement plant at Napa Junction under the name of the Standard Portland Cement Company. Geo. F. Cameron is president, home office, Crocker Building, San Francisco.

CLAY.

The only clay now produced in the county is the argillaceous shales mined at Glenwood by the Santa Cruz Portland Cement Company (see Cement). There are several good deposits of clay in the vicinity of Glenwood, and some common clay suitable for burning brick along the San Lorenzo River. During the early 90's two brick yards were in operation, both of which were situated on the San Lorenzo River, but have since been dismantled.

Bibl.: Repts. X, p. 625; XII, p. 383; XIII, p. 619.

COAL.

Several small veins of soft coal are known to occur in the Santa Cruz Mountains, but they have never been developed and are not of commercial value.

GOLD.

Gold is found in Santa Cruz County in auriferous black sand deposits; in placers of several creeks that flow down from Ben Lomond Mountain; and in small quartz veins on Ben Lomond Mountain, one of which was mined in the early 80's by F. B. Stirling[1] of Santa Cruz.

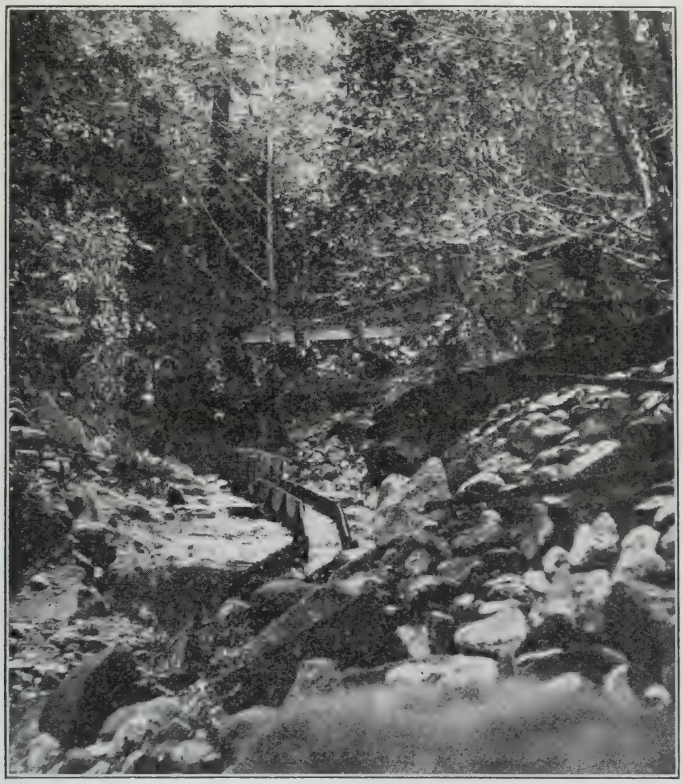


Photo No. 27. Sluice boxes of C. H. Jewitt in Gold Gulch. The six-inch pipe for carrying water up gulch is seen running along right side of and above the creek.

The discovery of a huge boulder containing a large amount of gold, upon which it is reported the Hihn fortune was founded, caused some excitement and led to considerable prospecting.

The following account of the gold extracted is taken from the History of Santa Cruz County by Harrison, page 203:

"In Santa Cruz County gold has been found at various times and in varying quantities, but no systematic effort has ever been made to develop this resource. A cañon known as Gold Gulch shows colors in almost any part of it, and wages have been made with a pan and shovel in this locality in days gone by. Many years ago a huge boulder was

[1]See Rept. VIII, pp. 551-552.

discovered in this cañon, from which was extracted $35,000 in gold. Whether this boulder was detached from a lead in the immediate vicinity or whether ages ago it was broken from the mother lode in the Sierras and found its way here, is a question that has not been determined."

A tunnel which is said to be over 900 ft. long was driven in the east slope of Ben Lomond Mountain above Gold Gulch in the hope of striking the lead from which the boulder originated. This tunnel is run in the soft sediments and is now caved. The parties doing the work abandoned the project after spending all their funds without finding the supposed lead.

The formations here are so faulted and broken that there is little hope of finding any continuity to any small stringers that might be encountered.

C. H. Jewitt of Santa Cruz formerly worked the placer deposits in Gold Gulch 2 miles south of Felton, under a two-year lease from the F. A. Hihn Estate. A centrifugal pump operated by a gas engine, installed above the mouth of the creek on the San Lorenzo River, pumped the water up the gulch through a 6" pipe. A "giant" nozzle was used against the gravel bank which was washed down through a series of sluice boxes.

Deposits of **auriferous black sands** occur along many of the beaches, particularly those along the northern shore of Monterey Bay extending from Soquel Point to the mouth of the Pajaro River. In the vicinity of Leonard Station these sands have been washed during the winter months, at intervals, for many years, the washers averaging from $2 to $3 daily per man.

Auriferous black sands are found on the Lizzie Leonard ranch ½ mile east of the coast in the low rolling sand hills which were formerly a sea beach. The black sands occur in strata from a few inches to several feet thick interstratified with light beach sands, and are said to carry a small amount of platinum as well as gold. The following varying analyses of samples of the black sands at Aptos, show a uniform low gold content. Many attempts have been made to extract the gold from these sands, none of which have been commercially successful.

POUNDS PER TON.

	Magnetite	Chromite	Ilmenite	Garnet	Olivene	Zircon	Quartz	Unclassified	Gold
1	668	8	340	10	9	26	752	189	$0.62
2	502	26	230	----------	4	18	1,046	170	.62
3	668	126	224	2	52	22	744	162	.62
4	672	72	250	1	62	24	814	104	.62

GRANITE.

Some granite was quarried from Ben Lomond Mountain several years ago. This stone is classified as quartz diorite, and is a fair building material. The stone is not at present used, however, due to its inaccessibility and distance from the market.

IRON.

Iron occurs in the auriferous black sand deposits on the Leonard ranch. Attention was recently directed to these deposits by a report prepared by L. T. Bachman, chemist of the Santa Cruz Portland Cement Company at the instigation of the Santa Cruz Chamber of Commerce for the purpose of determining the commercial possibilities of the manufacture of red oxide of iron and obtaining the gold and platinum as by-products from these sands. A complete survey of these sands was recommended before attempting any other work.

So far as could be determined there is no immediate likelihood of this work being undertaken.

LIME AND LIMESTONE.

Large bodies of highly crystalline white to bluish-white limestone or marble occur on Ben Lomond Mountain northwest of Santa Cruz and west of Felton. The limestone is shattered and broken and is not suitable for use as marble, but, it is in general very pure, running from 95% to 98% calcium carbonate, and is utilized for several purposes.

Six quarries are now being operated, the most important and largest ones for the manufacture of cement and the burning of lime. The stone from the smaller quarries is used for concrete work, for macadamizing streets in Santa Cruz, for flux, fertilizers, and formerly, to a small extent, for the manufacture of carbon dioxide.

The first lime kiln built in Santa Cruz County was in 1851 by I. E. Davis and A. P. Jordan; it afterward became the property of Henry Cowell. The old pot kilns may still be seen alongside of the Cowell road running from the Henry Cowell quarry to Rincon.

The burning of lime is the oldest mineral industry of the county, and second in importance to the manufacture of cement.

Caplatzi Quarry, formerly known as the **De Doro Quarry,** is located at the end of Spring street, Santa Cruz, about 2 miles northwest of the Southern Pacific depot, at an altitude of 250 feet. The rock is a coarse to fine-grained, highly crystalline, bluish-white limestone shattered and broken. It is worked by a large irregular cut, with a present face 40′ to 50′ high and several hundred feet in length, and quarried by air drilling and blasting. The stone is hauled by one-horse dump-carts to the crushing plant, which consists of a No. 4 Gates and a No. 2 Eureka crusher, 42″ Buhr mill, rolls, bucket elevators, screens, etc. The plant is operated by electric power. The limestone is ground for fertilizer (20 to 25 mesh), for poultry food (4 to 10 mesh) for flux (2″ and over); and also for concrete work. This quarry has been operated since 1907 by the present owner, W. A. Caplatzi of Santa Cruz. Seven men are employed.

Henry Cowell Lime and Cement Company, S. H. Cowell, president; W. H. George, secretary; home office No. 2 Market street, San Francisco. This company is at present operating the two following quarries in Santa Cruz County, both of which were opened many years ago and have been continuous producers since.

Henry Cowell Quarry.

This quarry is 2 miles northwest of Santa Cruz and one mile up a cañon beyond the old quarry first worked by Henry Cowell, where

is situated the pot kilns. Limestone outcrops in this cañon in many places and the deposit now being worked is very extensive, covering several acres. The limestone, usually covered with an adobe clay which has been washed down through the numerous cracks, lies fairly flat, dipping to the northwest. The stone is coarsely crystalline, white to grayish white. It has been quarried at several places along the cañon, but the present quarry is the largest, with a face over a hundred feet in height and several hundred feet in length. The stone is quarried by hand drilling, using giant powder to cave the face. It is shoveled into 5-ton wagons and hauled by 5-horse teams to the kilns. The coarsely crystalline white limestone is hauled to the pot kilns near the ranch house. Here are three kilns of 1200 bbl. capacity each, equipped with oil burners. About five days is necessary to thoroughly burn this stone. The dense and medium grained grayish blue limestone is hauled to the company's kilns at Rincon Station on the Southern Pacific Railroad, three miles northwest of Santa Cruz. A greater heat is necessary to burn this stone. The plant at Rincon consists of four 34-ft. oil-burning Standard continuous kilns. A set of three pot kilns of 1600 bbls. capacity each, is being built here to replace the old pot kilns at the ranch house. This will eliminate the heavy cost of transporting the fuel by wagons and concentrate the work at the railroad. The barrels in which the lime is packed are made in a cooper shop at the Rincon plant from redwood cut on the Cowell Ranch above Felton. An average of 50 men are employed at this quarry and at the two kilns.

Bibl.: Repts. VIII, p. 554; XII, p. 395; XIII, p. 631; Bull. 38, pp. 83–85.

I. X. L. Quarry.

This quarry is situated 2½ miles northwest of Felton at an elevation of about 800 ft. above sea-level. Steeply dipping beds of coarsely crystalline limestone form a bold projecting hill which lies at the confluence of two deep cañons. This hill is several hundred feet in height and has been quarried at several places. The limestone is shattered, and in places traversed by seams of silica, which has replaced the lime. The face of its present quarry is about 200 ft. in height. The stone is hauled by team to the three pot kilns located below the quarry. Wood, obtained from the surrounding hills, is used for fuel at these kilns. A cooperage is also maintained here to make the necessary barrels for packing the lime. About 20 men are employed. A. S. T. Johnson is superintendent for the Henry Cowell Lime and Cement Company, at Santa Cruz.

Bibl.: Repts. VIII, p. 555; XII, p. 395; XIII, p. 631; Bull. 38, pp. 86–87.

Holmes Lime and Cement Company, John Buck, Jr., president; O. M. Tupper, manager; home office, Postal Telegraph Building, San Francisco. This company owns and operates a quarry 2 miles northwest of Felton, ½ mile south of the I. X. L. Quarry. The limestone is exposed along the strike northwestward from the base to the top of a mountain of about 1000 ft. It is shattered and mica schist occurs in irregular patches through the deposit. There are several cuts at dif-

ferent elevations on the mountain, the principal working being about half-way up the mountain. The stone is hauled by a tram to the kilns near the town of Felton. There are four pot kilns and two Standard continuous kilns at this plant. Crude oil is used for fuel. The lime is barrelled at the kilns in barrels made at the property. An average of 30 men are employed during the greater part of the year. This quarry has been in operation over forty years.

Bibl.: Repts. VIII, p. 554; X, p. 626; XII, p. 395; XIII, p. 632; Bull. 38, pp. 85–86.

Miller Quarry, formerly known as the **Thurber Quarry,** is 2 miles northwest of Santa Cruz and south of the Caplatzi Quarry. The limestone is similar to that found in the other deposits of that vicinity. It is worked by a large shallow cut, the rock being crushed in a jaw crusher. The product is used for road and street work in Santa Cruz. Worked occasionally during past 20 years. Idle when visited. Owner is W. E. Miller, 81 Church street, Santa Cruz.

Bibl.: Rept. XIII, p. 631; Bull. 38, p. 88.

Santa Cruz Lime Company formerly operated a limestone quarry three miles inland from Davenport and adjoining the property of the Santa Cruz Portland Cement Company. Comparatively little lime was burned and the company is not now operating.

Bibl.: Bull. 38, pp. 87–88.

MINERAL SPRINGS.

There are a number of small sulphureted springs in Santa Cruz County, only one group of which has been improved and utilized commercially. This is known as **El Pajaro Springs** and is situated near the northern bank of the Pajaro River at Chittenden Station. A resort is conducted here with hotel accommodations, under the management of Geo. Sully of Chittenden. The following description is quoted from the report of Gerald A. Waring.[1]

"At least 12 cool, strongly sulphureted springs issue at this place along a sloping bank about 20 feet high that borders a flat willow-grown area along the river. The springs rise at intervals of a few yards for a distance of about 120 yards along the bank, being 25 to 50 yards from the edge of the river during the normal stages of the water. Three of the springs, each of which yields 1 or 2 gallons a minute, have been used locally for many years for drinking. One of these has been known as the Railroad Spring, as it has been a favorite with some of the railroad men. The other two, which are about 75 yards northwest of it, are known as White Sulphur Springs. The water of the Railroad Spring has the dark appearance that is characteristic of so-called black sulphur springs, but it becomes milky from suspended sulphur when it stands in an open vessel for a short time. The water of the White Sulphur Springs becomes milky and deposits native sulphur after flowing a few yards from the sources. The difference between the Black Sulphur or Railroad Spring and the White Sulphur Springs is possibly due to different degrees of oxidation of the sulphide constituents in the water as it reaches the surface.

The same feature is shown in several minor springs of the group.

[1]Springs of California, U. S. G. S. Water Supply Paper 338, pp. 274-276.

"The springs were long known locally as Chittenden Sulphur Springs, but were not improved until 1909 when concrete basins were constructed around the springs and the property opened to the public as Shale Sulphur Springs. Later the name was changed to El Pajaro.

"The following analyses of water from the Railroad Spring and the larger of the White Sulphur Springs show them to be secondary alkaline, primary saline waters:

Analyses of Water from El Pajaro Springs, Santa Cruz County, California.

(Constituents are in parts per million.)

	1		2		3	
Properties of reaction:						
Primary salinity		37		31		
Secondary salinity		0		4		
Tertiary salinity		0		0		
Primary alkalinity		1		0		
Secondary alkalinity		62		65		
Tertiary alkalinity	(?)		(?)			
Constituents	By weight	Reacting values	By weight	Reacting values	By weight	Reacting values
Sodium (Na)	199	8.63	159	6.94		
Potassium (K)	4.3	.11	4.5	.12		
Lithium (Li)	0	.00	0	.00		
Barium (Ba) and strontium (Sr)	0	.00	0	.00		
Calcium (Ca)	154	7.66	182	9.08		
Magnesium (Mg)	83	6.81	84	6.88		
Iron (Fe) } Aluminum (Al)	6.2	.22	2.8	.10		
Sulphate (SO_4)	150	3.12	234	4.85	85	1.77
Chloride (Cl)	193	5.45	109	3.08		
*Sulphur (S)	.4	.02	.8	.05		
Carbonate (CO_3)	402	13.41	392	13.07		
Metaborate (BO_2)	0	.00	0	.00		
Phosphate (PO_4)	0	.00	0	.00		
Silicia (SiO_2)	58	1.92	57	1.88		
	1,249.9		1,225.1			
Carbon dioxide (CO_2)	Present	Present	Present	Present		
Hydrogen sulphide (H_2S)	4.8	.28	8.6	.50	28	1.67
Methane (CH_4)			Present	Present		

*In suspension.

1. Railroad Spring. Analyst, Riddell and Mc Creary (1908). Authority, owner of springs.
2. White Sulphur Spring. Analyst, Riddell and McCreary (1908). Authority, owner of springs.
3. White Sulphur Spring. Analyst and authority, F. M. Eaton (1909).

"The first two samples were analyzed several weeks after they were collected. In order to determine, if possible, to what extent change had taken place in the unstable sulphur compounds between the times of collection and analysis, a sample from the White Sulphur Spring was later collected in a bottle containing iodine solution, so that the sulphide constituent was at once precipitated as sulphur according to the reaction $H_2S + 2I = 2HI + S$ and could be determined independently of the sulphate radicle. The sulphide and sulphate constituents were then determined within a few days of the time of collection, with the results shown in the analysis by F. M. Eaton. These results are not very satisfactory, however, for although the content of hydrogen sulphide is much greater in the sample treated with iodine than in

the other, the much smaller amount of sulphate indicates that there was a marked change in the concentration of the water during the year that intervened between the collection of the two samples. However, in the first samples there appears to have been a considerable increase in the amount of sulphate in the water on standing, and a decrease in the sulphides, a change that probably somewhat alters the medicinal properties of the water. Although sulphides were not reported in the analyses, the change that takes place in the sulphur compounds when the water stands for a time is believed to show that sulphides are present.

"Considerable inflammable gas rises in several of the springs. Analysis[1] of a sample of this gas indicates that it consists principally of methane (marsh gas, CH), with carbon dioxide (CO_2), and hydrogen sulphide (H_2S).

"A third of a mile north of El Pajaro Springs are two other springs, or wells. One issues at the base of a steep hillside through a 12-inch casing. A few bubbles of gas rise with the water and the surface of the pool that surrounds the casing is covered with a film of oil. The spring yields about 1½ gallons a minute of sulphureted water that becomes milky by the time it reaches a watering trough 10 yards away. The other spring is situated in meadowland, 300 yards northwest of the first. It yields perhaps 8 gallons a minute of clear water that is not noticeably sulphureted. It has been piped to a near-by storage tank for supplying cattle troughs.

"The rock of this area is light-colored shale of Tertiary age. Oil is obtained from wells a few miles to the northeast. The fault zone along which the earthquake of April 18, 1906, took place passes through the locality. The shale along the fault zone has been crushed by the earth movements, and landslides have been caused by the shocks. The issuance of gas and sulphur water along this zone of shattered material, where escape for them has been furnished, is noteworthy."

NATURAL GAS AND PETROLEUM.

There has been no commercial production of petroleum in Santa Cruz County although several small seepages, have been found and a few wells drilled. A well drilled to a depth of 700 ft. in 1901 on the Hughes tract 5 miles north of Watsonville is said to have encountered a 40′ bed of oil sands at 160′ depth and a 100′ stratum at 490′. A heavy flow of gas was struck at 640′ and the gas was utilized in the boilers for deeper drilling. The well was lost due to a heavy flow of sands and no further work has been done at this location.

Quoting from the report[2] of J. C. Branner, J. F. Newsom and Ralph Arnold.

[1]Analysts, Riddell & McCreary, 1908.
[2]Geology of the Santa Cruz Quadrangle U. S. G. S. Geological Folio 163.

SOLANO COUNTY.

Solano County touches San Francisco Bay on the northeast, and although mostly valley land, it is an important producer of mineral products. Developed and undeveloped resources include brick and clay, cement, chromite, coal, fullers earth, lime and limestone, mineral water, natural gas, petroleum, onyx, salt and miscellaneous stone. Most of these properties are described in the Fourteenth Report of the State Mineralogist. Such additions and changes as are here given will supplement the above and bring it to date.

"Apparently the most promising locality for prospecting for oil is that along the coast west and southwest from the outcropping bituminous rock beds, since those beds pass down under overlying shale in that region. Wells drilled here, however, failed to find oil, and it is supposed that the oil which must formerly have existed in the sandstones of the region has been drained off through large fractures which extended from the surface of the shale down to the underlying sandstone. Many sandstone dykes, some of them of large size, occur along the coast in this region. These were formed from the underlying oil-bearing sandstones and the larger ones probably represent the channels through which the oil from the underlying strata escaped."

Bibl.: Repts. VIII, p. 550; X, p. 622; XIII, p. 585; U. S. G. S., Geological Folio 163.

POTASH.

The **Santa Cruz Portland Cement Company** at Davenport erected a small experimental plant for the commercial extraction of potash from the flue dust and gasses emanating from the kilns.

A large deposit of soft decomposed granite located near the junction of Soquel and Hinckley Creeks 8 miles northeast of Santa Cruz was reported to contain a farily high potash content. No thorough sampling of this deposit has been undertaken, but samples analyzed by the chemist of the cement company mentioned above showed the percentage of soluble potash present to be too low for commercial extraction.

STONE INDUSTRY.

The **City of Santa Cruz** owns and occasionally operates a small quarry on the Big Tree road about 3 miles north of Santa Cruz. There is a small crushing plant at the quarry. The rock is used for road and street work by the city. It was idle when visited.

Caplatzi Quarry. (See under Limestone.)

Miller Quarry. (See under Limestone.)

BRICK AND CLAY.

Both the **Houze Brick and Cement Company** and the adjoining plant of the **Vallejo Brick and Tile Company, Consolidated,** have been idle during 1920, and for several years past. The United States Housing Corporation recently purchased most of this ground and erected housing facilities for employes of the Mare Island Navy Yard.

CEMENT.

Pacific Portland Cement Company, R. B. Henderson, manager; I. H. Colton, general superintendent of plants, including mountain quarries at Auburn and gypsum plaster plant, Mound House, Nevada; M. W. Locklin, plant superintendent, Cement, California.

Since publication of the Fourteenth Report, the old mill, "A," has been completely wrecked, and mill "B" is the only one operated. The plant has been running steadily throughout the year.

A new concrete "finished stock-house," consisting of 15 'Silo' and 8 'Star' bins, with a total capacity of 90,000 lbs., has been added. The 'Silo' bins are 20′ in diameter and 60′ high. The 'Star' bins are formed by partitions about 2′ long connecting the silo bins. Cement is drawn from the bins onto conveyor belts running in tunnels underneath.

Only about one-third of the raw rock used is mined at Cement, the balance coming from the Auburn quarries and from Mound House, Nevada. Three shifts are employed, and the mill has run to the full capacity of its 10 kilns. Wages are $4.50 per 8 hours for common labor, $5.50 for stock-house men. One and one-quarter time is paid for all over time. The company has had very little trouble with labor shortage, but some difficulty was experienced at times in getting cars. The large storage capacity of the new "finished" stock house has enabled continuous operation to be maintained, however. The small labor turnover is no doubt due in part to the company's rooming and boarding arrangements. A company hotel is run for employes at which both room and board may be had. There is also a separate dining room for employes who have their own cabins or rent company houses. Another feature is the company kitchens. These are used mainly by single men who "batch." One kitchen is used by about six men who do their own cooking, and it appears to be a very satisfactory arrangement, especially among the foreign element, whose different tastes are often difficult to satisfy in the regular boarding house.

FULLERS EARTH.

Western Fullers Earth Company. The fullers earth deposit ½ mile northeast of the railroad station at Vacaville which this company opened up is on the Blum ranch owned by C. H. Blum, 24 California street, San Francisco. The Standard Oil Company purchased 30 acres covering the principal exposure. They erected a small house and put down a well. During 1918 and 1919 several carloads of the material were mined and shipped, but the deposit has not been worked during the past year.

Fullers earth has also been found on **Old Rocky Ranch**, Dr. L. C. Marshall, Vacaville, owner. This lies a mile or so northerly from the Standard Oil Company's property, and is a probable continuation of the same beds. It is undeveloped.

MINERAL WATER.

Tolenas Springs. These springs were formerly under lease to H. W. Conkle of Suisun. They have been closed during 1920, and no water has been bottled.

Solano County—Table of Mineral Production.

Year	Quicksilver		Mineral water		Lime and limestone		Stone industry. Value	Value	Miscellaneous and unapportioned	
	Flasks	Value	Gallons	Value	Tons	Value			Kind	Value
1873	1,800	$144,594								
1874	1,900	199,842								
1875	2,100	176,715								
1876	1,683	74,052								
1877	1,463	54,570								
1878	802	26,386								
1879	1,290	38,507								
1880	492	15,252								
1881										
1882										
1883										
1884										
1885										
1886										
1887										
1888										
1889										
1890										
1891										
1892										
1893										
1894					6,400	$8,000	$225			
1895					4,300	4,635	19,650			
1896			3,094	$1,547	5,477	5,989	15,752		75 tons pottery	$125
1897					9,608	9,801	20,975		400 tons pottery	500
1898					6,125	5,570	15,065			
1899			20,000	4,000		356	12,581			
1900			20,000	4,000	1,800	1,800	18,900			
1901			17,800	4,450		5,950	2,200			
1902	42	1,890	10,000	4,000			14,250		75,000 barrels cement	150,000
1903	100	4,100	10,000	4,000			21,514		250,000 barrels cement	375,000
1904	*377	15,080	10,000	4,000			11,113			
1905	542	18,518	10,000	4,000	100,000	100,000	78,573			
1906	528	19,272	4,000	4,000			143,487			
1907	640	24,422	40,000	4,000			202,146	$6,584	125 tons salt	600
									3,000 M brick	25,000

1908	764	33,294	140,000	11,600			527,319	8,053	400 tons salt	2,800
									1,000 M brick	7,000
1909			32,650	5,490			176,813	7,538	100 tons salt	200
									1,600 M brick	20,000
									5,600 tons clay	11,200
1910				32,400	3,960		241,949	9,100	50 tons salt	150
1911			30,000	4,000			181,952	8,596	100 tons salt	300
									500 M brick	4,000
1912			285,050	44,000			130,445	8,528	50 tons salt	100
									2,200 M brick	20,000
1913			23,600	3,440			28,915	7,366	Unapportioned, 1900-1913, inclusive	13,570,019
1914	320	15,696	43,020	5,208	86,128	86,128	71,288	5,546		1,500,000
1915			64,200	8,000			37,576			1,290,347
1916	660	61,710	11,200	3,750			49,711		Principally cement, fuller's earth,	1,090,164
1917	554	52,765	10,960	2,580			39,826		natural gas, salt and onyx	1,804,060
1918	593	59,122	11,440	2,722			30,124			1,378,758
1919							44,156			1,627,928
Totals	16,650	$1,035,787	829,414	$132,747	219,838	$228,229	$12,136,505	$61,311		$22,878,251

*Flasks of 75 pounds since June, 1904; 76½ pounds previously.

Totals.

Quicksilver	$1,035,787
Mineral water	132,747
Lime and limestone	228,229
Stone industry	12,136,505
Natural gas	61,311
Miscellaneous and unapportioned	22,878,251
Grand total	$36,472,830

Vallejo White Sulphur Springs. This property is now generally known as **Blue Rock Springs,** the bottled water being called Blue Rock Water. There is a swimming pool, hotel, and camping accommodations.

NATURAL GAS.

Rochester Oil Company. This company made no effort to produce during the year. The well has been neglected, and the gas flow has gradually diminished until only a small amount is now obtained. They are negotiating with some of the other oil companies who contemplate drilling for petroleum in the vicinity for the sale of their holdings. See Bulletin No. 89.

PETROLEUM.

Besides earlier attempts (see XIV Report) **Wm. Hanhuth** of Vallejo et al. drilled a well near Suisun without results and disincorporated. The **Honolulu Consolidated Oil Company** has also recently become interested in this field. Bulletin No. 89 contains a full report of the possibilities of the section and development attained during the year.

QUICKSILVER.

St. Johns Mines Company. This was the only quicksilver mine in the county operated during the year. Twelve men employed.

STONE INDUSTRY.

County Crushed Rock Plant. The county has erected bunkers and a trommel screen at the dump of the St. Johns Quicksilver mine. Rock from the dump is crushed and screened, three sizes being produced. The material makes an excellent road metal, and its distinctly red color gives a pleasing appearance to the highway.

Lambies Gravel Pit. There is a deposit of reddish sandy gravel on the Lambies Ranch in the W. ½ of section 4 and E. ½ of section 5, T. 4 N., R. 1 E. The gravel has been used on the country roads by the county and others for many years. It makes a good surfacing material, and gives a pleasing red color to the road. The county pays 25c per load for the gravel.

Southern Pacific Company. The railroad company quarries rock at several points along their right of way for ballast and fills. These are worked intermittently.

Thomasson Quarry. (Also known as **Cordelia** or **McNaughton's.**) Owned by E. B. and A. L. Stone Company; E. B. Stone, president; H. A. Keefer, secretary and sales manager, 804 Claus Spreckels building, San Francisco; A. Hanson, superintendent at plant. This plant was operated continuously during the year. The contract system of working and the production of paving blocks have been discontinued. Day labor is used, a minimum wage of $5.50 per 9 hours being paid. There has been a scarcity of men at times. Thirty were employed at the time of visit.

Crushed rock is the only product. Sizes furnished are—

$1\frac{1}{2}$" to $2\frac{1}{2}$".
$\frac{3}{4}$" to $1\frac{1}{2}$".
$\frac{1}{2}$" to 1".
$\frac{1}{4}$" to $\frac{3}{4}$".
Dust to $\frac{1}{4}$".

Waste sells for 50c per yard.

In June, 1920, all sizes were quoted at $1.85 per yard.

Eleven motors are used throughout the plant, and the number of bunkers has been increased from 12 to 18 with a corresponding increase in capacity from 2000 to 2700 tons. A washing plant estimated to cost $45,000 will be installed shortly. Salt water pumped from Cordelia Slough will be used.

Vulcan Rock Company. This quarry has been idle for the past three or four years. All equipment has been removed. It is reported that the rock was of rather poor quality.

SONOMA COUNTY.

Sonoma County is both a coast county and one of the "North of the Bay" group. It lies north of Marin County and San Pablo Bay and extends from the Pacific Ocean on the west to Lake and Napa counties on the east. Mendocino County bounds it on the north. The northern two-thirds is drained into the Pacific by the Russian River and its tributaries, but the southern part is drained by Petaluma and Sonoma Creeks into San Pablo Bay. The main valley, through the central part of the county, is sixty miles long by twenty-five miles wide.

The mineral products of Sonoma County are diversified and include brick, chromite, clay, copper, graphite, infusorial earth, magnesite, manganese, marble, mineral paint, mineral water, quicksilver, and miscellaneous stone.

The Fourteenth Report of the State Mineralogist contains a general report on the mineral resources of the county. Bulletin No. 78 covers the quicksilver mines in detail and Bulletin No. 76, the manganese and chrome deposits. Such changes and new developments as have occurred during the present year only, are here noted.

CHROMITE.

None of the chrome deposits described in Bulletin No. 76 were producing during the present year.

Parmeter Ranch Deposit. This property is now known as the **Laton Group.** Owner, A. H. Laton, et al.; home office, 1601 Posen avenue, Berkeley, California.

There are three claims in this group, the Rattlesnake, Lone Bird and Serpentine, located in section 13, T. 9 N., R. 12 W. Eight miles by good road from Cazadero, the nearest railroad point. The mine has an elevation of 800 to 900 feet. There is a good water supply and some small mountain cedar on the claims. Country rock is serpentine. The first work was done in 1916 by B. M. Bauman. Mining continued in 1917 and part of 1918 by A. H. Laton. It was closed down late in 1918. Some high grade kidneys were found, but the deposit, as a whole, is low grade, and concentration will be required to obtain a shipping product. The total production to date has been 200 tons. This was sold to the L. B. Butcher Company of San Francisco.

Jones and Cranson have a chrome deposit about 2 miles north of the Culver-Baer Quicksilver Mine, and along the same ridge. George Elder worked it in 1918 and shipped about 150 tons.

COPPER.

Cornucopia Copper Mining Company. Assessment work has been kept up on this property.

MAGNESITE.

Healdsburg Marble Company. This property was operated by the California Magnesia Company for about one year. A brick lined concrete furnace of the shaft type was erected on the railroad at Guerneville in 1917, where the magnesite was calcined. The property is now closed down and the calcining plant was dismantled this year and sold.

Local reports state that poor management was largely responsible for closing down.

Kolling Deposit. This property is known as the **Refractory Magnesite Mine.** It has been idle since the beginning of 1919. F. R. Turton (deceased) was president of the Refractory Magnesite Company, who last worked it. The magnesite was calcined and ground at the mines and shipped to South San Francisco. The plant is well equipped. Power was furnished by three gas engines. The furnace is of the shaft type and rests on a concrete foundation. Fuel oil was used. Fuel oil pumps, crusher, rolls, Sturtevant mill, air compressors and gas engines are all housed in a substantial building. This property has been recently examined by a San Francisco engineer from C. L. Wilson, Hobart Building, San Francisco, and it is reported that it is soon to be operated again.

Snyder Ranch. There is said to be an undeveloped deposit of magnesite on the Geo. Snyder Ranch on Piney Creek, about 12 miles southwest of Healdsburg.

MANGANESE.

Shanks and Copps Lease. This property, described in Bulletin No. 76, was last operated by Hyde Flannigan of Sacramento. Their lease expired in July, 1920, and the mine was closed in June of this year. The total production to date has been 900 tons. There is said to be considerable ore still remaining.

C. C. Foss has a manganese prospect on his ranch in section 19, T. 11 N., R. 8 E., about one mile above "The Geysers."

MINERAL WATER.

Alder Glen Springs. This resort has not been opened during the present season.

Mark West Springs. Purchased by W. H. Otterson in 1917.

Salvation Army's Boys' and Girls' Industrial Home and Farm, Incorporated, formerly **Lytton Springs.** Commissioner Thos. Estill, Chicago, Illinois, president; Lieutenant Colonel Arthur Smeeton, Lytton, California, vice president and treasurer; Staff Captain Jacob A. Koerner, Lytton, California, secretary.

In April of this year the main administration building was destroyed by fire. A new concrete building is being erected. In addition to the "Soda" and "Seltzer" Springs, there is one of cold sulphur water. Water is free to the public. The water is no longer bottled.

Skaggs Hot Springs. The swimming tank is supplied by the combined overflow of all the mineral springs. There are accommodations for 250 people in the hotel, cottages and tents.

The Geysers. This famous property has been leased, with option to purchase, by John D. Grant, of Healdsburg. A new bath house has been built and opened this year where hot steam and sulphur baths may be had. The hotel is lighted by electricity generated on the property by water power.

QUICKSILVER.

The quicksilver mines of Sonoma County have been described in detail in Bulletin No. 78. Of the thirty or so mines whose history is given therein, but one was in active operation during the present year.

Cloverdale Mine. This mine has been in steady operation throughout the year. Through the courtesy of Mr. Andrew Rocca, Jr., superintendent, the following data, regarding the present reduction equipment, from the report of Mr. C. N. Schuette of the U. S. Bureau of Mines Station at Berkeley, was made available:

"The modified Livermore furnace equipment as in 1918 was unsatisfactory on account of small capacity and faulty construction caused by excessive salivation of furnacement.

Erection of rotary furnace began Oct. 17th and was completed in 79 days. Minor troubles caused irregular operation in January and February. Steady operation began in March. The kiln leads into a 3-comp. concrete dust chamber from which the gases pass through a double line of 15″ tile pipe to two 15′ x 26′ wooden tanks in series and then to 30′ stack 2′ in diameter.

The ore bin is above the dust chamber. Spent ore from kiln drops into large concrete pit under bin box. Furnace and condenser tanks are built over concrete floors. The tile pipes are underlaid by tarred roofing paper.

The plant is operated by a 25-h.p. Fairbanks Company ore engine, which drives kiln, rock crushes, compressor and feeder. Ore brought down gravity incline, over grizzly above ore bin—oversized bin crusher to bin of 125-ton capacity. Crushed to 2″ size.

Rotary Kiln. 56′ long and 4′ outside, upper six feet coned to 3′ in outside diameter. Lined with 5″ fire brick, slope $\frac{1}{2}$″ to 1′ toward discharge. Brick firebox over concrete pit has opening for oil burner and small door in case of clinkering. Peep hole for sampling in side of fire box. Rotated by belt drive at fixed speed. Furnace fed by inclined pipe with longitudinal shaking motion, devised by Mr. Rocca, extending six inches into furnace and running through dust chamber. The pipe is fed by a Challenge feeder. Fume tight joints are provided between furnace and dust chamber and furnace and firebox.

CONDENSER SYSTEM.

(Double strength tile pipe used throughout.)

Unit and data	Area square feet	Volume cubic feet
3 compartment concrete dust chamber 4′ 4″ x 7′ 4″ x 11′ 6″ 4′ 10″ x 7′ 4″ x 11′ 6″ 3′ 2″ x 7′ 4″ x 11′ 6″	970	1,040
2 lines tile pipe 15″ dia., 135′ long	1,060	332
Wooden tank condenser 15′ dia., 26′ long	1,581	4,602
Tile pipe 21″ dia., 25′ long	138	60
Wooden tank condenser 15′ x 26′	1,581	4,602
Tile pipe 21″ dia., 7′ long	39	17
Stack 2″ dia., 30′ high	188	94
	5,557	10,747

Dust chamber divided in 3-comp. by baffle walls. The two lines of pipe are provided with drains, sprays and cold air injection. Wooden tanks have sloping floors and drain through lowest point to concrete pots. Door in side of tanks. Every fourth joint in the tile lines has a T for cleaning purposes.

OPERATION OF FURNACE.

Power. 25-h.p. Fairbanks-Morse engine, drier kiln, 6 x 6 WG 3 Sullivan compressor, 10 x 16 Blake crusher and Challenge feeder. Tonnage 75 tons per twenty-four hours at 1 r.p.m. Ore assay between 10 and 15 lbs. Hg per ton, moisture 2 to 7%.

Furnace feed. Through 8″ inclined pipe kept full by Challenge feeder. Rotation of furnace draws ore away from pipe end. Ore is a hard siliceous chert and has strong abrasive action on kiln liners and joint between furnace and dust chamber.

Discharge. Burned ore falls into concrete pit from where it is drawn into cars and trammed to dump 150′ away. Drawn from pit through arc gate in bottom. Car tunnel is ventilated by 28″ galvanized iron pipes which lead hot air dust from rear end of tunnel to air above furnace building. The capacity is such that the drawing of a twenty-four hour run of waste rock can be done by one man in eight hour shift. The furnace tailings are clean, no cinnabar or free mercury and nearly dustless.

Fuel. Consumption has average for 1919 of 7.55 gals. per ton of ore. A Witt oil burner is used, the oil being atomized by compressed air. Compressor runs at 221 r.p.m. and delivers 7.35 cu. ft. a minute at 55# gage pressure. Air is preheated by coiling air line three times around hot end of kiln. Oil delivered by gravity and preheated by laying line across hot floor above waste bin. Oil tank 125′ above furnace, feed line 2″. If too hot a fire is maintained the furnace will clinker.

Furnace crew. Four men, one man per eight hour shift attends to operation of furnace, one man works twelve-hour shift, attends retort and trams burned rock to dump.

OPERATION OF CONDENSER SYSTEM.

(See Blue Print.)

Gas travel. The distance the gas has traveled at points of observation are:

Station 1	Feet
1	50
2	180
3	230
4	270
Top stack	300

Draft. Natural draft—vertical distance between kiln and top of stack 80′.

Date	Temperatures—Data				
	Station 1	Station 2	Station 3	Station 4	Atmosphere
March 10, 1919	175	82-76	56	53	17
	178	58-55	50	46	15
March 11, 1919	208	58-60	54	50	14
	221-220	52-55	49	46	13
March 12, 1919	234-234	60-66	56	53	13
	240-240	57-60	54	46	11
March 13, 1919	240-237	52-62	54	50	12
March 14, 1919	238-239	61-63	52	51	7

A blower which was used to blow cold air into the system was disconnected as it increased the gas volume enough to cause a slight pressure in dust chamber and caused furnace to back fire.

Gas analysis for Co_2 ab Stations 1 and 4 with Honigman burrette.

Date	Time	CO^2 at Station	Station 2
March 12, 1919	10.00 10.30	10.6	8.8
March 13, 1919	8.45 9.00	11.4	8.0
March 14, 1919	8.30 8.45	9.9	6.7

These results show that inward flow of air varied between 20% and 50% of original gas volume.

Spray. Water spray (see blue print) designed to arrest any dust passing dust chamber. Is ordinary garden nozzle pointing up hill in each pipe adjusted to give very fine conical spray. Spray from both nozzles 4.5 gals. per minute. Water entered pipe at 15° C. and was heated to about 53° C. The drain pipe emptied in a concrete pot from which the water overflows to a series of settling boxes.

Clean up. By washing down tanks and pipe with water. Overflow passing to settling boxes.

Soot is worked with lime and retorted.

This furnace installation has practically cut operating costs in two."

Culver-Baer Mine. This mine was closed down in February, 1919, on account of high costs and unsatisfactory labor conditions.

Squaw and Big Chief Claims. Assessment work has been kept up on the Squaw Claim, but the Big Chief has been abandoned.

STANISLAUS COUNTY.

Stanislaus County is the leading dairying, and one of the principal agricultural counties in the state. Its mining interests are relatively small, being confined to a narrow strip along the west border, which includes areas of Miocene, Cretaceous and Franciscan, sand stones, shales, lime stones and serpentines of the Mount Diablo Range, and a small area at the eastern extremity of the county which enters the Jurassic slates of the foothills of the Sierra Nevadas.

BUILDING MATERIAL.

Clay suitable for the manufacture of brick has been utilized at various times in the past from deposits near Modesto, Grayson, Newman and Patterson, although at the present time there is no brickyard in operation in the entire county, and none of the clays are being used for any purpose. The plant of the Modesto Repressed Brick Company, which was mentioned in the Fourteenth Report of the State Mineralogist, has been dismantled, and the ground upon which it was located has been sold as town lots.

Mr. Martin Kelch manufactured a small number of brick during the years 1918 and 1919 from a clay deposit located on the Waterford Road about a mile east of Modesto, but owing to the difficulty of obtaining satisfactory help, he has discontinued operations, and is attempting to sell his holdings, which consist of nine acres underlaid with a bed of clay, having a maximum thickness of twenty feet, with little or no overburden.

The gravel pits mentioned in the Fourteenth Report located near Oakdale are still being operated intermittently. The **Dixon Gravel Pit** is now owned by Samuel and Roy Kauffman of Oakdale; additional work is being done by the State Highway Commission operating a rock crusher and sand pit in the bed of the Stanislaus River at Knights Ferry; a similar plant is operated by **Palmer and McBride,** San Francisco contractors, above the Orange Blossom Bridge about three miles below Knights Ferry. The two last mentioned plants are being temporarily operated for the purpose of securing material for use in paving the Oakdale lateral of the State Highway.

CHROMITE.

Stanislaus County became a producer of chrome ore early in 1916. Most of the deposits so far developed are situated on the east slope of the Coast Range Mountains in the Aurora del Puerto Cañon and its branches. This industry has been practically at a standstill since the signing of the armistice, and the detailed account of various properties contained in Bulletin No. 76 still hold true in all important detail.

COAL.

Several small veins of coal have been discovered at various times in the southwest portion of Stanislaus County, notably in section 12, T. 6 S., R. 7 E.; section 12, T. 5 S., R. 6 E.; and on the Hoges Ranch about 13 miles northwest of Newman. None of these deposits have been thoroughly investigated or developed to date.

GOLD.

The Bureau's records contain a mention of but two gold quartz mines in this county—the **Alto,** situated in the Calaveras grant near Knights Ferry, which has long since been abandoned, and the **Don Pedro,** near Cooperstown, which is included in a reservoir site recently purchased by the Turlock Irrigation District, and which will soon be flooded by the waters of the reservoir, and made entirely inaccessible.

The **LaGrange Gold Dredging Company,** H. G. Cumberly, superintendent, is still operating its dredge on the Tuolumne River, at La Grange, and according to the company's estimates enough ground remains for at least ten years more work. Further details relative to this enterprise may be found in the Fourteenth Report, and in Bulletins Nos. 57 and 85.

The **Yankee Hill Gold Dredging Company,** E. R. Healy, manager, Oakdale, California, launched the hull of a new dredge May 8, 1920, at a point on the Stanislaus River, 1½ miles below Knights Ferry. Installation of machinery was immediately undertaken, and actual digging operations were begun on November 19, 1920. Electric power is used; the buckets are four and a half cubic feet capacity, close connected. Fifteen men employed.

MAGNESITE.

Various magnesite deposits have been discovered and worked to some extent in the southwest portion of the county. The situation with regard to most of them has not changed singe the compilation of Bulletin No. 79, entitled "Magnesite Resources of California." Among new developments noted in May, 1920, were the activities of the **Plastic Magnesite Company,** owned by D. W. Shanks and H. H. Harlan, 625 Market street, San Francisco; property located in section 32, T. 8 S., R. 7 E., 16 miles west of Ingomar, Walter H. Parsons, superintendent, Ingomar post office. The bed or vein which is being worked is from four to eight feet thick, dipping about 15° to the south. The material is removed through a 350-ft. tunnel, and workings consist of about 350 ft. of drifts with both overhand and underhand stopes. Fifteen men are employed and daily production amounts to about 30 tons, some of which is hand-sorted. At the time the property was visited (May, 1920) three 2-ton trucks were hauling about twenty tons of magnesite per day to the railroad at Ingomar.

MANGANESE.

Considerable manganese occurs in the northwest corner of the county, in the southeasterly extension of the belt of Franciscan serpentine, which begins near Tesla in Alameda County. The production of manganese in this belt had assumed proportions of considerable size at the close of the war, but only work on a very small scale has been carried on since that date. Detailed description of deposits may be found in Bulletin No. 76, page 83.

OCHRE.

Deposits of both red and yellow ochre have long been worked in the vicinity of Knights Ferry. Outcroppings occur in many places on

both sides of the Stanislaus River. Development on a small scale is now under way at the following properties:

Bartlett Ranch, J. G. Fulton, lessee, Knights Ferry post office, operating on ground adjoining the Voyle deposit. A tunnel is being driven to cut the ochre bed, which had reached the distance of 16 ft. in May, 1920.

Schaefer Deposit, situated near Knights Ferry about ¼ mile from the Voyle mine on land leased by C. L. Schaefer of Jamestown, from the San Francisco Light and Power Company. There are two men employed. Ochre is removed from the tunnel in wheelbarrows, and dried on platforms before shipping. Small production reported in 1920.

Wiedman Ranch Deposit, Prowse and Williams, lessees, Knights Ferry. This property, which is idle and undeveloped, is located directly across the Stanislaus River from the town of Knights Ferry.

Voyle Mine, Jack Winkler, lessee, Knights Ferry, worked intermittently on small scale during past few years, has been described in Fourteenth as well as earlier reports of State Mineralogist.

PETROLEUM.

Considerable interest has been taken in the petroleum possibilities of the county during the past year or more. Full details relative to this subject will be found in Bulletin No. 89, entitled "Petroleum Resources of California," recently issued by the Bureau. In May, 1920, active drilling operations were under way by the Southern Oil and Gas Company near Oakdale, and by Pattee Brothers and Ellis, near Knights Ferry. The Pioneer Oil Company of Oakdale, organized May 18, 1920, had obtained lease on land located between Oakdale and Knights Ferry.

The **Turlock Oil and Gas Company,** organized March 12, 1920, hold under lease 340 acres in section 34, T. 5 S., R. 9 E., as well as a large additional acreage in T. 6 S., R. 9 E., which lies in Merced County. In addition to the above, oil seepages have been reported at several places in the vicinity of Crows Landing, and it is said that the occurrence of oil in sufficient quantities to make the water unfit for drinking has long been known on the Frankheimer Ranch, 9 miles northeast of Oakdale.

QUICKSILVER.

Quicksilver was first discovered in this county in about 1875, on both the north and south forks of Orestimba Creek in the Mount Diablo Range. Since that time several deposits have been opened up and developed to some extent. Nothing of interest has been done there during the past year, and detailed description of the various properties will be found in Bulletin No. 78, "Quicksilver Resources of California."

SILICA.

Deposits of comparatively pure silica, both in ledge formation and as sand, occur in the vicinity of Patterson. These deposits are described in detail in the Fourteenth Report. No development work has as yet been undertaken.

SUTTER COUNTY.

Sutter County is one of the least important mineral-bearing areas of California. The entire county is covered with a deep alluvial soil, with the exception of a circular area about ten miles in diameter, which includes the Marysville Buttes.

CLAY.

Clay beds, none of which have been commercially utilized, occur in the sedimentary strata of the buttes. These beds contain clay, which could be satisfactorily used for the manufacture of brick and pottery, should the demand arise.

COAL.

Thick seams of lignite have been noted in certain of the beds of the Ione formation, lying above the clay deposits just mentioned.

GOLD.

No gold-bearing veins have been found in the Marysville Buttes, but certain coarse gravels occurring in the sedimentary Ione strata have been found to be auriferous. The gravels consist of water-worn pebbles which, no doubt, originated in the Sierra Nevadas.

NATURAL GAS.

Small quantities of gas have been encountered in wells drilled for water at Yuba City. These wells have all been shallow and the gas encountered was in such small quantities that it has not been commercially utilized.

LIMESTONE.

An impure clayey limestone is said to occur just south of South Butte. A spring deposit consisting principally of calcite is reported to occur about $1\frac{1}{2}$ miles southeast of South Butte. Neither of these deposits have been investigated to date.

STONE.

A quarry in the rhyolite rock, three miles northwest of Sutter City, has furnished some building stone, which was used locally. The county has also utilized crushed rock from the Buttes, in the construction of highways.

TULARE COUNTY.

Tulare County, one of the largest counties of the San Joaquin Valley, lies south of Fresno, west of Inyo and north of Kern. The western half of the county extends across the San Joaquin Valley and the eastern half lies in the Sierra Nevadas. The eastern boundary includes Mount Whitney, which is the highest peak in the United States, with an altitude of 14,501 feet.

Tulare County has for several years been the most important source of magnesite in California. In addition to magnesite, many other minerals occur within its boundaries, some of which have been developed and others which are awaiting more favorable transportation facilities and market conditions. The Bureau did no field work in Tulare County during 1920, but interested parties are referred to the Fifteenth Report of the State Mineralogist for details relative to individual mining operations in this district. The following notes on mineral deposits, both developed and undeveloped, are presented as a matter of general information.

ANTIMONY.

The presence of antimony has been noted at various points in Tulare County although the only deposit upon which any development work has been done, is at the Lady Alice Mine near Mineral King on the east fork of the Kaweah River.

ASBESTOS.

In the serpentine area east of Porterville are some small deposits of asbestos, none of which have been prospected. There is also a deposit on the McCann ranch, 1 mile south of White River and another on the James ranch, north of Porterville. Asbestos of unproven quality has been obtained in Frazier Valley, 25 miles southeast of Tulare City. The demand for asbestos is constantly growing and it is understood that the best material now commands a price ranging up to $400 or $500 per ton. These grades are utilized in the manufacture of tapestries, theatre curtains, cloth, etc. The lower quality of asbestos which is unsuitable for weaving and which, of course, commands lower prices, is used in the manufacture of steam packing, furnace linings, wall plasters, paints, tiling, insulating materials, etc. An important development of the asbestos industry is the rapidly increasing demand for the lower grade material on account of the numerous and diversified uses to which such profits are being put in almost every branch of manufacture.

CLAY.

South of Porterville there is a large deposit of fire clay which, from tests made, is reported to produce a fine quality of fire brick. In the neighborhood of Exeter and Visalia there are extensive deposits of brick clay. Six miles east of Porterville there occurs a strata of clay shale about 2000 feet in width. The quality of this material appears to be suitable for the manufacture of tile, sewer pipe and steam products.

CHROMITE.

In the foothills north and southeast of Porterville a number of deposits of chromite of good commercial grade have been developed and considerable production reported. Among the better known properties may be mentioned the Waddell, the Vaughn, Sattlefield and James mines. The principal use of chrome is as a refractory lining in steel and copper furnaces. Smaller amounts are used in the preparation of ferro-chrome and in the making of chromates for tanning and other purposes. The demand for this substance is temporarily slack but it is believed that the situation will not continue indefinitely, particularly as regards material of the higher grade.

COPPER.

In this county there are some very promising copper prospects, but owing to the ruggedness of the country and the distance from transportation, they have been but little explored and very slightly developed. Just east of Porterville there is a belt about five miles wide extending to the Yokohl Valley, in which small veins occur. This area is most clearly defined and characterized by narrow diversified seams or stringers of copper bearing minerals. The largest deposits, however, are in the central portion of the county, thirty miles or so east of Porterville, along the north fork of the middle fork of the Tule River. Copper prospects of possible future value occur high in the Sierras in the extreme northeast corner of the county.

GEMS.

At various places along the foothills of the Sierra Nevadas, extending entirely across Tulare County has been noted a variety of siliceous minerals capable of use in the arts for ornamental purposes, such as rose quartz, garnet, chrysopal, etc. In the past a very active interest was taken in these gem minerals but of late years the demand has fallen off to some extent.

FELDSPAR.

Feldspar is widely distributed throughout this portion of the state, considerable production having been reported from deposits near Three Rivers, Lemon Cove and in the vicinity of Exeter.

GOLD.

The only productive area where gold mining has been carried on to any extent is in the White River district, situated fifteen miles southeast of Porterville. Some very promising prospects have been noted in the Globe district, twelve miles east of Porterville, as well as on Cow Mountain and elsewhere.

GRANITE.

In the foothills east of Porterville and Exeter there are extensive deposits of biotite granite which is suitable for building purposes. Up to the present time only relatively small amounts of development work and production have been undertaken.

GRAPHITE.

So far as the Mining Bureau is informed no graphite has ever been produced in this section although deposits are known to exist in Drum

Valley, north of Auckland and about three miles west of Dunlap. On account of its inaccessibility and resistance to the action of molten metal, graphite is very valuable. It is also largely used in the manufacture of electrical appliances, lubricants, paints, stove polish and in many other ways.

GYPSUM.

Gypsum has been reported to exist in Tulare County, notably in section 21, T. 30 S., R. 22 E., although it is believed that these deposits have not even been prospected. This mineral is used as a fertilizer and also in the manufacture of plaster and cement. In the calcine form as plaster of paris, gypsum plays a very important part in surgical work.

IRON.

Undeveloped deposits of iron ore are located near Mineral King, at an elevation exceeding 10,000 feet. On account of their inaccessibility, we have little definite information regarding their value or extent.

LIMESTONE.

There are extensive deposits of limestone in the foothills and mountainous regions in the eastern part of the county. On the north and south fork of the Tule River there are large belts of limestone and extensive deposits also occur in the vicinity of Three Rivers and on various forks on the Kaweah River in the Mineral King district.

MAGNESITE.

Tulare County is one of the principal magnesite producing sections of California. Magnesite deposits a short distance northeast of Porterville were discovered as early as 1853. Active operations were unimportant until about 1900 and during the past twenty years development has been quite active. The most extensive deposits are east of Porterville, Lindsay and Exeter.

MANGANESE.

Manganese ores have been noted north of Springville and northeast of Lindsay, although little development has been done upon them.

MINERAL WATERS.

Throughout Tulare County in the Sierra Nevada Mountains are large numbers of Hot and Carbonated springs. Among the more important may be mentioned the California Hot Springs, thirty miles southeast of Porterville, on the west bank of Deer Creek, the Coburn Soda Spring at Springville, the Doyle Soda Springs, thirteen miles east of Springville, Little Yosemite Soda Springs in the Kern National Forest, two and one-half miles north of Kern Lake, Nelson Soda Springs, fifteen miles east of Springville and the Tule River Springs, sixteen miles east of Porterville.

ZINC-LEAD ORES.

On the McGuinnis, Empire, White Chief, Lady Franklin and Silver Lake claims, there are valuable deposits of lead and zinc ores. This district was discovered in 1873, the first location being made on the

White Chief Claim, about two and one-half miles south of the town of Mineral King. In 1879 and 1880 there was a rush to this district. Owing to the inaccessibility and the distance from transportation, as well as the complex character of the ores, only spasmodic attempts at mining have been made. More recent discoveries of zinc have been reported on North Alder Creek, sixteen miles northeast of Springville.

YOLO COUNTY.

Yolo County is one of the Central Sacramento Valley group. Its mineral resources are limited in number and but slightly developed. Those products that have been commercially produced are quicksilver, sandstone and miscellaneous stone. Deposits of brick clay, coal, gold, iron, limestone, manganese and quicksilver are known and a number of mineral springs are found in the county.

The location and description of these deposits are given in the Fourteenth Report of the State Mineralogist; the quicksilver mines in the northeastern corner, near the Napa County line, are more particularly described in Bulletin No. 78. When visited during the summer of 1920, **Bufords Spring,** situated along Putah Creek about nine miles west of Winters, was being improved with the idea of making it a resort.

Yolo County—Table of Mineral Production.

Year	Quicksilver		Sandstone		Miscellaneous and unapportioned	Value
	Flasks	Value	Cubic feet	Value		
1873	*905	$79,928				
1874	3,000	315,510				
1875						
1876	965	42,460				
1877	1,516	56,547				
1878	1,640	53,956				
1879	1,110	33,134				
1880	422	13,082				
1881						
1882						
1883						
1884						
1885						
1886						
1887						
1888						
1889						
1890						
1891						
1892						
1893						
1894			2,500	$1,000		
1895			542	1,873		
1896			252	378		
1897						
1898			264	384		
1899			264	384		
1900			908	1,760		
1901			1,540	2,300		
1902			328	450		
1903			280	144		
1904			180	720		
1905			175	200		
1906			160	204		
1907			250	350		
1908			140	1,150		
1909						
1910						
1911						
1912						
1913						
1914	15	736				
1915					Stone, miscellaneous	$1,200
					Other minerals†	840
1916					Stone, miscellaneous	300
1917					Stone, miscellaneous	4,300
					Other minerals†	1,261
1918					Stone, miscellaneous	17,915
					Other minerals†	3,300
1919					Stone, miscellaneous	5,600
					Other minerals†	19,866
						$54,582
Total value to end of 1919						$861,262

*Flasks of 76½ pounds.
†Under "Other minerals" to conceal output of a single producer.

LOS ANGELES FIELD DIVISION.

By W. BURLING TUCKER.

Part I.

SCOPE OF MINERAL INDUSTRY.

The Los Angeles district consists of eleven counties, extending from Imperial and San Diego counties on the south, to and including Riverside, San Bernardino, Kern, and Inyo counties on the north; also the counties of Orange, Los Angeles, Ventura, Santa Barbara, and San Luis Obispo along the Pacific Coast of Southern California. The eastern part of the district is made up largely of mountain and desert country, and is highly mineralized, while the western part along the coast range, with foothill and valleys to the east, contains a great variety of commercial minerals, including also most of the structural and industrial materials, as well as metals.

The district contains the largest known and most productive oil fields in the state, the principal producing counties being Kern, Los Angeles, Orange, Santa Barbara, and Ventura.

The most important mineral products are: Asbestos, barytes, bituminous rock, borax, brick and tile, chromite, cement, clay, coal, copper, diatomaceous earth, dolomite, feldspar, fluorspar, gems, gold, granite, graphite, iron, lead, lime, limestone, magnesite, manganese, mineral paint, mineral water, miscellaneous stone, natural gas, niter, petroleum, potash, quicksilver, salt, silica, sodium, sulphate, soapstone, talc, and tungsten.

In order of their value, the several leading products are as follows: Petroleum, natural gas, structural and industrial materials, salines, and metals.

Riverside and San Bernardino counties led all other counties in the state in the variety of minerals commercially produced. Kern, Orange, and Los Angeles counties in the order named led all other counties in the state in mineral production due to the petroleum output.

GENERAL CONDITIONS DURING THE PAST YEAR.

Petroleum.

The production of petroleum increased during the past year, being mainly due to greater oil development in the different oil districts, and of new productive fields, as Montebello, Richfield, and Huntington Beach.

Structural and Industrial Materials.

Due to the increased demand for building material during 1919 the capacity of the different cement plants was somewhat increased, and all the plants were running to capacity.

Crushed rock, stone, and sand were in demand for concrete construction of buildings and pavements, so the different rock plants resumed operations on an increased scale the latter part of the year.

Salines.

American Trona Corporation completed their plant at Trona on Searles Lake, and were large producers of potash.

Two other plants were built during the year by Solvay Process Company and the West End Chemical Company on Searles Lake for

the extraction of potash, and at present writing are on a producing basis.

On Owens Lake, Inyo County, the following companies were large producers of soda: Natural Soda Products Company, California Alkali Company. Both these companies increased the capacity of their plants.

The Consolidated Chemical Company started active operations on the sodium sulphate deposits of Carrizo Plains, San Luis Obispo County.

The Pacific Coast Borax Company were large shippers of borax from their mines near Ryan, Inyo County, and also operated their mill to capacity.

Metals.

Due to the increase in price of silver there was renewed activity in mining in the Silver camps of Inyo and San Bernardino counties.

There was no activity in gold mining in the district during the past year, and what mines were operating during 1918 were compelled to suspend operations on account of increased cost of production.

Due to low metal prices there was very little activity in mining or the production of chromite, manganese, and quicksilver.

GENERAL OUTLOOK FOR THE COMING YEAR.

There should be an increase in production of petroleum, natural gas, and of structural and industrial materials in 1921.

On account of unfavorable market conditions, and the increase in freight rates there will be very little activity in metal mining.

Transportation.

There are four railroad systems, for which Los Angeles is the terminus. Three of these four lines are transcontinental, as follows: Atchison, Topeka and Santa Fe, Southern Pacific, Los Angeles and Salt Lake. These railroads and their feeders pass through the different counties of the district, and afford ample transportation facilities to the different market centers. The Tonopah and Tidewater Railroad, which connects with the Santa Fe system at Ludlow, affords an outlet for northern end of San Bernardino, and the eastern end of Inyo County. The Pacific Electric Railroad operates a system of over 1000 miles, radiating to all points in Southern California.

The steam and electric railroads operating to and from Los Angeles have numerous direct and interchangeable dock, warehouse and track connections with each other throughout the greater part of southern California, as well as shipside connections for loading from shipside to cars at the Port of Los Angeles.

Power.

The district is well supplied with electric power by the Nevada-California Power Company, Southern Sierras Power Company, Pacific Light and Power Company, and Southern California Edison Company.

The Southern Sierras Power Company serves the different mines and plants in Inyo, Kern, and San Bernardino counties, with lines extended from San Bernardino through Riverside to El Centro in Imperial County.

Water.

Throughout certain desert regions of Inyo, Kern, San Bernardino, Riverside, San Diego, and Imperial counties water is scarce, and this lack of water has held back the development of the mineral resources of these counties. In the High Sierras and the Coast Range the supply is ample under normal conditions, and the streams from these ranges furnish sufficient water for power and operation of plants in the counties in close proximity.

Labor.

The supply of labor has been limited during the past year, and what was to be secured was inefficient. During the coming year labor conditions should be much improved, and more plentiful.

Part II.

Los Angeles District: By Counties.

IMPERIAL COUNTY.

Imperial County does not contain a great variety of mineral deposits; however, it contains valuable deposits of clays, gold, gypsum, crystalline limestone, pumice, manganese, salt, and sodium sulphate.

The principal lrawback in mining and developing these materials has been due to lack of transportation. With the completion of the San Diego and Arizona Railroad the possibilities appear bright for the development of the marble and gypsum deposits in the Coyote and Fish Creek mountains.

The recent discovery of sodium sulphate deposits in the Salton Sea Basin, in the neighborhood of Pope Station and Durmit, northwest of Niland, promises to add greatly to the mineral wealth of the county.

GOLD.

The gold deposits of this county are in the southeastern corner, occurring in ranges with northwest trend, between the line of the Southern Pacific Railway and the Colorado River. The chief gold-producing districts have been in the Cargo Muchacho and Pichacho ranges of mountains.

At present, due to the general depression in the mining industry, there is nothing being done in these districts.

Bibl.: Rept. XIV, pp. 724-732.

GYPSUM.

The gypsum of Imperial County occurs mainly in an immense deposit some three miles in length from southeast to southwest, with an area of 800 acres, which occupies a valley among crystalline rocks, in the northwestern edge of Fish Creek Mountains. The gypsum outcrops are in sections 19, 20, 28, 29, T. 13 S., R. 9 E. The gypsum beds have an average thickness of 100 feet. The San Diego and Arizona Railroad passes within 25 miles of the deposit.

Situated on the south slope of the Coyote Mountain Range is a large deposit of gypsum covering the better part of 10 acres. It is exposed over most of this area, has an average depth of 8 feet. Estimated to be 80,000 to 100,000 tons that can be easily mined. This deposit lies about 3 miles northwest of Coyote Wells.

Bibl.: Rept. XIV, pp. 738-740.

GRAPHITE.

Stuart Graphite Deposit. It is situated on the southeast slope of Coyote Mountains, 7 miles north of Coyote Wells, a station on the San Diego and Arizona Railroad. Two claims have been located on the deposit. A vein of amphorous graphite 4 feet wide occurs in a wide belt of schist, which strikes NW. and SE. Croppings can be traced for several hundred feet. Stuart and King of San Diego, owners.

LIME AND LIMESTONE.

On the south slope of Coyote Mountain and at a point 3½ miles southwest of Coyote Wells are great deposits of limestone. It is reported that the limestone carries little or no magnesia, which makes it valuable for cement.

MARBLE.

The chief deposits of this material in the county are in Coyote Mountain, townships 15 and 16 S., R. 9 and 10 E. This mountain is largely formed of crystalline limestone. These deposits are 6 miles north of Coyote Wells, a station on the main line of the San Diego and Arizona Railroad.

The **Creole Marble Deposit.** The Creole group consists of four claims, covering an outcrop of marble about 4500 feet long and averaging 600 feet wide. Practically all development has been done on Creole Claim No. 1. Here are three distinct stratas of marble. The marble has a hardness of 3.5 and the colors range from blue-black, cream-pink, white, mottled black and white, and blue. Deposits are estimated to contain 3,000,000 cubic feet of marble. Three men are employed quarrying marble and hauling by tractor to Coyote Wells. Marble is sawed at the mill of Lyman Onyx and Marble Company of San Diego. Owner, Golden State Mining and Marble Company, C. A. Walker, president; Harry F. Roberts, secretary, 309 Watts Building, San Diego, California.

Bibl.: Rept. XV, pp. 733-736; Bull. 38, p. 107.

Southern California Marble Deposit. The deposit is situated in the Coyote Mountains, 6½ miles north of Coyote Wells, on the main line of the San Diego and Arizona Railroad, and about one mile northwest of the Creole marble deposit. The limestone belt strikes N. 30° E., and has a general dip of 60 to 70 degrees east. The outcrops reach a height of 150 feet to 200 feet above the base exposure and are 100 to 500 feet in width, and between 500 and 1200 feet in length. The exposed surfaces in many places are much jointed and fractured, due to their long exposure to the elements and climatic conditions. Three quarry faces have been opened up along this belt of marble, from 150 feet in length to 30 feet in height, which expose solid faces of marble, which can be quarried in large blocks. All the marbles are of fine texture, hard and admit an excellent polish, as shown by samples taken from the property. As commercial marble they rank with Georgia white and the English vein marble, also with Italian white marble. There are also outcroppings of several colored marbles as yet undeveloped, but of a character similar to Rose Numidian, Noir Veine, and Breccia. It is estimated that these deposits contain several million cubic feet of marble. Holdings consist of 440 acres. Claims are known as the Mammoth, Mammoth Annex, Big 6, and Big 6 Annex No. 1 and No. 2. Located in sections 1 and 2, T. 16 S., R. 9 E., section 35, T. 15 S., R. 9 E.

Five men employed on development work. Southern California Marble and Development Company, J. G. Morley, president; S. E. Lewis, secretary; Jas. S. Fowler, superintendent; offices, 3799 Ibis street, San Diego, California.

MANGANESE.

Deposits of manganese ore occur in Imperial County, in the Palo Verde Mountains about 5 miles west of the wagon road between Palo Verde and Glamis and in the Paymaster district in an outlying spur of the southeastern part of the Chocolate Mountains. The Colorado River is about 4 miles east of the deposits. The Paymaster district is accessible from Glamis, on the Southern Pacific Railroad, by a wagon road 32 miles long.

The deposits of manganese ore in the Palo Verde district are contained in a number of short veins or shear zones that cut basic lava flows. The veins have a general strike of N. 65° E. and are vertical. In the Paymaster district the deposits of manganese ore are contained in fissure veins that cut both the sedimentary and igneous rocks. The veins strike from N. 10° W. to N. 50° E., and dip from 65 degrees E. to vertical. The manganese oxides are dominantly psilomelane, though with increasing depth the softer oxides, manganite and pyrolusite become more abundant.

All the mines in the above mentioned districts are idle, suspending operations in the latter part of 1918, due to the low market price of manganese.

For detailed description of the different deposits see California State Mining Bureau Bulletin No. 76, pp. 34-35; U. S. G. S. Bulletin No. 710-E, pp. 200-208.

PETROLEUM.

There has been a revival of activity throughout Imperial County in drilling for oil, and four wells are now being drilled by different companies.

The present oil excitement in Imperial Valley is not the first of its kind. Numerous attempts have been made to find oil in years past but without success. Among the wells previously drilled were the Harper or Mesquite well, about 850 feet deep, in section 27, T. 12 S., R. 10 E., the Hudson well in township 14 S., R. 10 E., and the Yahu Buttes well. The principal well was the Yahu, section 32, T. 16 S., R. 11 E., drilled by the **Yahu Oil Company.** It reached a depth of 1363 feet, but without result.

At the present time the following oil companies are drilling wells in the county: San Diego and Imperial Valley Oil Company, known as the "James" well, section 9, T. 16 S., R. 10 W. This well is being drilled with a portable steam outfit with Standard derrick. Depth 1000 feet.

The **Imperial Oil and Developing Association** Well No. 1, section 32, T. 11 S., R. 10 E. The well is about 2500 feet deep, having drilled through shale or sandy shale to present depth. Reported gas encountered in this well.

Diamond Bar Oil Company Well No. 1, section 25, T. 11 S., R. 9 E., S. B. B. and M. Depth 2500 feet. Gas showing reported.

104 Oil Company Well No. 1, in section 11, T. 14 S., R. 16 E. Depth of well being about 1000 feet, having drilled through sandy shale.

Quoting from Irving V. Augur's report on Drilling Operations in Imperial Valley in "Summary of Operations California Oil Fields," Vol. 5, No. 10, April, 1920, issued by California State Mining Bureau.

Each of the wells now drilling starts in the younger beds of the Carrizo formation. The San Diego and Imperial Valley well is located on the south flank, and considerably south of a plunging anticline in this formation.

The Imperial Valley Oil and Developing Association well and the Diamond Bar Oil Company's well are located on well-pronounced domes in the Carrizo formation and if able to penetrate to the base of this formation should determine whether or not oil may be found on the west side of the valley. It is evident that the Carrizo formation is the only formation in which oil can be expected, since this formation rests directly upon the basal complex.

A large amount of acreage in the valley has been sold recently by the Southern Pacific Company, and by the state, and thousands of acres of government land have been filed on as placer claims.

The following-named companies are among the many which have been reported as preparing to begin active operations this year:

Salton Basin Oil and Gas Association, Kobarstekeck Oil Company, South Western Petroleum Company, Pacific Gas, Oil and Refining Company, Barbara Worth Oil Company, Canopas Oil Company, H. L. & K. Company, Imperial Valley Oil Syndicate, California Imperial Syndicate, Delta Oil and Gas Company, Mount Signal Oil Company, Colorado Desert Oil Company.

A few of the above-mentioned companies' holdings include patented land, but the larger number are organized to develop government lands. Filing on claims is still very active, although many of the unpatented lands are now under entry. Probably many of the wells which it is proposed to drill will not actually be started unless a definite oil showing is found in one of the wells now drilling or to be drilled in the near future.

For detailed information on the Petroleum Development in Imperial County see "Summary of Operations California Oil Fields" of the State Oil and Gas Supervisor, issued by State Mining Bureau, Vol. 5, No. 10, April, 1920.

PUMICE.

Brand and Stevens Pumice Deposit. It is situated 9¼ miles northwest of Calipatria, in section 32, T. 11 S., R. 13 E., S. B. B. and M. Consists of a group of placer claims covering whole deposit, embracing about ¼ section. A deposit of pumice of undetermined thickness lies on a low, rounded hill about 20 feet high above the surrounding flat, which is in the Salton Sea Sink, 180 feet below sea level. It is evidently the slopes of an old crater which has been filled with sand and ash. The deposit covers probably 100 acres. The work so far done is confined to an open cut, whose face is 250 feet long and about 20 feet in depth. The pumice occurs as broken angular pieces throughout this face, probably 40% of the material being pumice. The remaining material, which forms a filling, is sand and ash. The pumice occurs in pieces varying in size up to 10 inches, the average being probably 1½" to 4". Larger pieces are rarer and form a small percentage of the whole. The pumice is silver gray in color and appears to be uniform

in character. Occasional pieces of obsidium are found with it. Large flows of the obsidium lie on two sides of the deposit, forming low, broken hills. Material is mined by pick and shovel. Pumice sorted out by hand, and a team and scraper used to haul away the sand. Pumice is hauled to Calipatria at a cost of $2.50 per ton by 5-ton auto trucks. Four to six men are employed. H. W. Brand and E. E. Stevens, owners, 606 Hibernian Building, Los Angeles, California.

SILICA.

A bedded deposit of silica sand occurs in the Coyote Mountains on the holdings of the Southern California Marble and Development Company.

The deposit is located 7 miles north of Coyote Wells, a station on the San Diego and Arizona Railroad.

The bed of silica is about 50 feet thick, and can be traced for $\frac{1}{4}$ of a mile along a gulch west of No. 3 quarry. The sand is clean and white and would be suitable for making glass.

SILVER AND LEAD.

Silver occurs with lead, 1 mile south of the Colorado River and 5 miles east of Picacho. The ores are lead carbonate and galena, which occur in small veins or pockets. Wm. Swain of Picacho owns a number of claims.

The old Paymaster silver mine, which is located in the northern part of Barren Mountain, is being worked by Malcolm McLeach of San Diego, California. A cyanide plant has been installed and the old tailings and dumps are being treated. Four men employed.

SODIUM SULPHATE.

Deposits of natural sodium sulphate occur in Imperial County, in the Salton Sea Basin, near Bertram and Pope Stations on the Southern Pacific Railroad.

A deposit owned by E. N. Smith of El Centro, California, is situated east of Bertram Station, in township 9 S., R. 12 E., S. B. B. and M.

Beds of sodium sulphate stated to be from 1 to 12 feet thick, and from 50 to 300 feet wide, can be traced for a distance of one mile. Overlying these bedded deposits is an overburden from 6 to 12 feet thick of unconsolidated sand and gravel. It is stated the deposit is very pure, running 95% sodium sulphate ($Na_2 SO_4$). About 5000 tons have been developed, and will be shipped to the glass manufacturers in Los Angeles.

G. E. Miller of Niland owns a deposit southeast of Durmit Station on the Southern Pacific Railroad. It is reported that the beds of sodium sulphate are from one to 8 feet in thickness, with an overburden of sand and gravel. The deposits are reported to have been recently sold to Los Angeles interests.

STRONTIUM.

Deposits of celestite occur in the Fish Creek Mountains, associated with gypsum, in Imperial County.

W. F. Peler and **D. R. Roberts**, of Los Angeles, have several claims on these deposits, which are situated 40 miles west of Brawley, a station

on the Southern Pacific Railway. The celestite beds are underlain by beds of gypsum. The ore is finely crystallized, but generally white in color.

During 1916, 40 tons were shipped from deposit to B. F. Mortimer of Los Angeles, for the manufacture of sodium nitrate.

During the past two years no further developments have been made on these deposits.

INYO COUNTY.

INTRODUCTION.

The field work for this report was carried on during the year 1920, the object being principally to report on the new developments in the mineral resources throughout the county since the Fifteenth Report of the State Mineralogist.

Appreciation is expressed for the courtesy and assistance tendered by the owners and operators of the mines.

LOCATION AND DESCRIPTION.

Inyo County lies along the eastern border of California, and is bounded to the north and south by Mono and San Bernardino counties, respectively. The western boundary extends to the Sierra divide. The county has an area of 10,224 square miles, being the second largest county in California. Independence is the county seat, while Bishop is the center of population.

Within the borders of the county are both the highest point and the lowest point in the United States—Mount Whitney having an elevation of 14,501 feet, while the lowest point in Death Valley, at Salt Flat, is 280 feet below sea level.

TRANSPORTATION.

Mines located in the region of Owens and Amargosa Valleys are easily accessible from the Southern Pacific and the Tonopah and Tidewater railroads. Roads and trails make the interior of the county accessible, but hauling is difficult because of steep grades and deep sands.

POWER.

Electric power, generated in the Sierras west of Bishop, is available in the northern and western parts of the county. The eastern and southeastern and central portions of the county are dependent on internal combustion engines for generating power at the mines.

Two companies at present have hydro-electric plants on Bishop Creek. The Nevada-California Power Company, owning three plants, confines its operations exclusively to the State of Nevada. The Southern Sierras Power Company has three hydro-electric plants on Bishop Creek. Their lines extend from the plants on Bishop Creek down the Owens Valley, with branches to Keeler, to Big Pine, to Palmetto, Nevada, and north to Lundy, Mono County.

ANTIMONY.

Wildrose Mine. Situated in Wildrose district. Lies on western flank of Panamint Mountains, south of Wildrose Cañon, and 45 miles by road north of Trona. Elevation 5000 feet. Irregular veins of stibnite, varying in width from a few inches to over a foot, are deposited in schist. The general trend of the stringers is east and west, and their outcrops can be traced for several thousand feet along ridge. Workings consist of numerous open cuts and a large number of tunnels. Idle.

Owned by the Western Metals Company, Security Building, Los Angeles, California; M. Elsasser, manager.

Bibl.: Repts. XII, p. 21; XV, p. 60.

Williams and Johnson Prospect. Located on eastern slope of Argus Mountains, between Revenue and Shepherd Cañon, 18 miles by road north of Trona. The deposits of stibnite are said to outcrop at intervals over distance of 1500 feet. Owners, Ralph Williams and George Johnson of Bishop, California.

The occurrence of antimony is reported in the east flank of the Panamint Mountains. As the deposits are very inaccessible, they have never been developed, and little is known concerning them.

BORAX.

Borax was first discovered in Inyo County in 1874, in the Playa deposits of Saline Valley. A few years following the discovery in Saline Valley, the marshes in the vicinity of Resting Springs and of Death Valley, north of Furnace Creek, were found to contain borax crust, and were worked until 1890. Some years after this date extensive deposits of colemanite were found in the foothills of the Black Mountains east of Furnace Creek. They extend in narrow belt for many miles, and are owned by the Pacific Coast Borax Company. The southernmost deposit was located seven miles southwest of Death Valley Junction and known as the Lila C. mine. This mine has been a continuous producer from 1907, and is a small producer at present writing.

The **Pacific Coast Borax Company** is at present the only producer of borax in Inyo County and is mining colemanite from the following mines of the company: Upper Biddy, Lower Biddy, Grand View, Lizzie V. Oakley, Played Out, Widow Mines.

The main camp, called Ryan, is at the Biddy McCarty Mine, twenty miles north of west of Death Valley Junction. The Death Valley Railroad, a narrow gauge controlled by the same company, connects Ryan with Death Valley Junction. Ore trains operated by gasoline motors haul ore from the different mines to the main storage bins at Ryan. The borate-bearing beds of this vicinity are a part of a series of tertiary lake beds, which consist of thin-bedded, light-colored shales. Underlying these shales are thick beds of coarse sandstone and tuff. The sandstone exposures form conspicuous bluffs at the camp of Ryan below the upper Biddy workings. The borate-bearing beds are capped with basalt, which forms the crest of the ridge back of the mine.

The colemanite deposits are distinctly bedded and vary in thickness up to 100 feet. The strata have been considerably faulted so there is no great regularity to the deposits.

The purest deposits are usually found nearest the capping. The colemanite occurs massive and more or less crystallized. The crystals occur both in prismatic form, varying from minute size up to a couple of inches in length, and in radiating or plumose structure in the beds. Underlying the purer beds, colemanite is found as stringers in the shale, due to leaching and recrystallization of the upper beds. It is also found mingled with shaly matter which ore is necessarily concentrated. The ore from the different mines is segregated into first and second class ore, the first grade ore is shipped direct to the refineries at Bayonne, New Jersey, or Alameda, California, while second class ore goes to concentration plant at Death Valley Junction.

Biddy McCarty Mine (Upper Biddy). Situated at Ryan, the terminus of the Death Valley Railroad. Elevation 2900 feet. The general trend of the colemanite beds is northwest and southeast with dip of 45 degrees to northeast.

The beds are from 20′ to 100 feet thick, and are worked by means of glory hole, also underground stoping below quarry level. Ore extracted from glory hole and stopes is trammed out through a tunnel 210 feet in length to main storage bins. Recently this main haulage level has been extended east through the hill a distance of 1800 feet, and will be used as main haulage way for ore trains from Grandview, Oakley and Widow Mines. Chute from glory hole is 190 feet from portal of tunnel.

Lower Biddy Mine. This mine is situated ¼ mile northwest of Upper Biddy. The colemanite beds strike N. 50° W., and dip 40

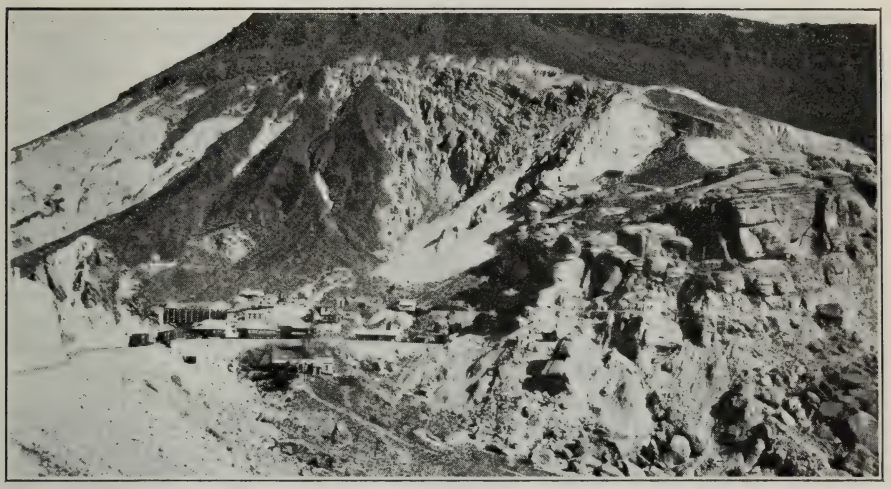


Photo No. 28. Biddy McCarty Mine (Upper Biddy), Ryan, Inyo County. Pacific Coast Borax Company. Photo by W. B. Tucker.

degrees to southwest. The beds have a thickness of 6 to 10 feet. The ore is mined by means of glory hole and a series of tunnels driven in under the ore body at different elevations. Ore from these workings hoisted over incline tramway by 20-h.p. hoist to storage bins, from which which bins is loaded into cars of the Death Valley Railroad.

The main power plant is at the Biddy McCarty mine: 16″ x 9¾″ x 12″ Sullivan compressor driven by 100-h.p. Fairbanks-Morse Semi-Diesel type of engine. Air from this central plant supplies the different properties with power for air drills.

Grand View Mine. This mine is situated about 1 mile south of Ryan, on slope of ridge east of Furnace Cañon. Elevation of 2950 feet.

At the elevation of main haulage track a crosscut tunnel has been driven east, cutting colemanite beds, which strike northwest and southeast and dip to the northeast. The deposit has also been developed by a series of crosscut tunnels at a higher elevation. The colemanite beds

have a thickness of 6 to 20 feet. Ore trammed from workings to storage bins, where loaded into ore train and hauled to main storage bins at Ryan.

Oakley Mine. It is situated south of the Grand View mine and about 1¼ miles south of Ryan, at an elevation of 2800 feet. The main workings on the property are at a lower elevation than the main haulage way from Ryan to the Widow Mines, and are connected with main haulage system by a spur track. The colemanite beds on this property strike northwest and southeast and dip 45 to 50 degrees to northeast. The deposit is developed by a number of crosscut tunnels driven east at different elevations. At a higher elevation are what is known as the upper workings which are now being developed by the company, and some well defined ore bodies have been developed. Ore from this mine is picked up by ore trains and hauled to Ryan to main storage bins.

Played Out Mine. It is situated 2 miles north of Ryan. Elevation 2900 feet. The colemanite beds on this property strike north 50 degrees west and dip 40 degrees northeast. These beds have a thickness of from 10 to 25 feet. Main working tunnel is driven north 50 degrees east, 800 feet, cross cutting belt of sandstone and shale, failing to cut ore body. A raise was then put up 140 feet to ore body on sixth level. A drift has been driven south 30 degrees east, 200 feet in ore which shows a width of 20 feet of colemanite and ulexite.

These beds have been developed by 5 tunnel levels above main haulage level. On No. 1 level or quarry level the ore body is 300 feet long and 20 feet thick. Ore extracted from quarry, drifts and stopes goes to main ore chute and is dropped down to lower tunnel level, then trammed to storage bins on railroad. At these bins the ore passes over a grizzly, and the high grade ore is sorted out.

Widow Mines. They are situated on ridge east of Furnace Creek Wash, at an elevation of 3386 feet. Seven different deposits have been opened up on this property, all of which have been developed in the past year. The strata here has been considerably faulted so there is no regularity to the deposits.

On Widow No. 3 deposit, the colemanite beds strike north 60 degrees east and dip 40 degrees southeast. Thickness of beds being from 20 to 200 feet, with an ore body 300 feet long. Underground workings consist of a cross-cut tunnel driven 1250 feet northeast to ore body, then continued to hanging wall of ore deposit 150 feet. Raise from this level through ore to No. 2 level, a distance of 100 feet, then drift run 700 feet northeast in ore. Raise continued 55 feet to No. 1 level, on this level a cross-cut tunnel has been driven southeast 300 feet in ore. No. 1 tunnel has been driven 200 feet northeast along the footwall of vein. This level connects with glory hole on the surface, the ore from glory hole goes to ore chute that connects with main tunnel level.

No. 7 Widow Deposit.

Crosscut tunnel has been driven 200 feet north to vein, and a drift run southeast 500 feet in ore. The colemanite deposit on this level is 50 to 60 feet thick. Drifts have been driven both on hanging and footwall of vein, and crosscuts run connecting these drifts every 50 feet.

About 70 feet below these workings a main haulage tunnel has been driven northeast 200 feet to ore body. The colemanite bed on this level is over 100 feet in thickness and from 300 to 500 feet in length.

A large tonnage of ore has been developed on this group of claims, and the Widow Mine promises to be the largest producer of any of the properties so far worked by the company.

Ore is loaded in cars direct from chutes in two main lower adit tunnels, and hauled by gasoline motors in trains of ten ore cars, each train hauling 30 tons a distance of 2 miles to main storage bins at Ryan.

Most of the mining is done by hand drilling, but all development work is done with air drills.

About 205 men are employed at the different mines, producing 75 to 100 tons of first class ore, and about 300 tons of second class ore. All second class ore is concentrated at Death Valley Junction.

Concentration Plant.

The ore is fed into a No. 5 gyratory crusher and crushed to pass 2″ ring, and passed through Allis-Chalmers 24″ rolls, spaced so as to crush $\frac{7}{8}$″ size, or finer. A belt conveyor elevates the crushed ore to two large storage tanks (capacity 80 tons each) from which it is automatically fed to six 6′ x 50′ rotary roasters. The roasters are fitted with inner chambers which carry the ore so that the flame does not come in direct contact with the ore. Crude oil used as fuel. The roasting temperature is 1300° F.

The material from roasters passed over double deck shaking screens, top screen being $\frac{1}{4}$ mesh, and lower screen 24 mesh. Minus 24 mesh product is a finished product, and is conveyed by screen conveyors to sacking plant. Plus $\frac{1}{4}$ and on 24 mesh material elevated to bins in concentrating plant. Then fed from bins to 24 mesh trommel screen, oversize from trommel to set rolls—where crushed through $\frac{1}{4}$″ ring. Crushed product from rolls elevated to set of trommels where resized on 24 mesh, oversize going to 6 Hartz jigs, and minus 24 mesh product to six Wilfrey tables, where a finished product is taken off.

Jig concentrates goes to Colorado impact screen for dewatering. Tailings from jigs and tables dewatered by Dorr and Drag classifiers. Tailings from concentrating plant conveyed by belt conveyor 500 feet in length to waste dump.

Jig and table product rough dried on steam plates, then passed through Ruggles-Cole dryer. Finished product from roasters and concentrating plant, averages 42% to 45% $B_2 O_3$, is sacked upon cooling and shipped to the refineries, for the manufacture of boric acid, and borax products.

A recovery of 85% is made by concentration. The plant makes a recovery of 95%. Present capacity of plant is 300 tons per day. At present 285-h.p. Diesel engine supplies power for operating plant. A 500-h.p. Diesel engine is being installed, which will in future furnish the power to operate the plant. Eighty-five men employed. Pacific Coast Borax Company, owner, Syndicate Building, Oakland, California; R. C. Baker, president; W. F. Wemphal, secretary; John Ryan, general manager; Major J. Boyd, mine superintendent; F. W. Corkill, mill superintendent.

Bibl.: Rept. XV, pp. 62-69.

COPPER.

Although there are deposits of copper in many localities in Inyo County, there has been very little production from ore bodies that contain copper as the predominating metal. The greatest production has been that in association with gold, silver and lead ores containing small percentages of copper. Due to the low price of copper since the latter part of 1918 there has been no mining of copper-bearing ores in the county.

There are valuable deposits of copper ores in the following districts: Ubehebe, New Coso, and Greenwater. The ores are principally the oxides and carbonates of copper, with some chrysocolla, and occasionally sulphide. These districts and the mines have been fully described in Report XV, pp. 69 to 74, therefore no attempt will be made to go into a detailed description of the individual properties.

DOLOMITE.

There are extensive deposits of dolomite in Inyo County, but owing to their distance from railroad transportation they are not of commercial value.

The most extensive deposits are situated on the western flank of the Inyo Range of Mountains, near Keeler.

In the Keeler district, north of Swansea, the rock is being quarried and shipped to the soda plants on Owens Lake, where the dolomite is used for generating carbon dioxide.

Badgley Quarry, Swansea (Keeler) district. Four miles north of Keeler, at western base of Inyo Mountains. Eighty acres patented. Marble beds here are folded and shattered. Quarried for use as dolomite. Idle. Owned by W. A. Badgley of Monadnock Building, San Francisco, California.

Bibl.: Report XV, p. 74.

Natural Soda Products Company of Keeler are shipping 100 tons per day of pure white dolomite from their quarry to the soda plant at Keeler. One air compressor furnishes air for drills which are used in quarrying the rock. A spur track of the California and Nevada Railroad to quarry. Worked under contract by Emil Hernandez. Seventeen men are employed.

Bibl.: Report XV, p. 74.

California Alkalai Company of Cartago are shipping about 50 tons of dolomite from company's quarry to the Cartago plant, and the Inyo Development Company's plant. The quarry is situated about 2 miles north of Natural Soda Products Company quarry. Air drills are used in quarrying the rock. Fourteen men are employed by Emil Hernandez, who is mining the rock under contract.

GOLD.

Since the last report issued by the State Mineralogist there has been practically no activity in gold mining in Inyo County. Lack of interest in the development of the gold properties has been mostly due to the fact that cost of material, labor and supplies have risen to such a point that it is no longer profitable for the gold miner to operate his property.

Unless some relief is given the gold industry there will be no incentive for the prospector or the operator to attempt to develop properties.

In Report XV, pp. 75 to 85, a complete description of the different mines is given, so the writer will only attempt to outline what few properties that are operating, and those properties not reported on in previous reports.

MINES.

Black Eagle Mine. (Quartz.) Union district. Situated on west flank of Inyo Range of Mountains, 4 miles east of Kearsarge Station. Elevation 8300 feet. The ore body is a narrow quartz vein on the contact of granite and limestone, but is enclosed principally in the granite. The vein trends N. 70° E. and dips nearly vertical. A shaft has been sunk to depth of 310 feet on the vein and a number of levels run east and west on the vein. It is reported that on the third level there was a shoot of ore developed 400 feet in length. The ore is usually high grade; and by sorting it is said to have averaged $100 per ton in gold. The mine is being reopened by the Inyo-Black Eagle Mining Company, F. W. Cole, president and manager; offices 512 I. W. Hellman Building, Los Angeles, California. Five men are employed on development work.

Bibl.: U. S. G. S. Bull. 540, p. 116. Report XV, p. 75.

Buckeye Mine (Never Rest Mines). Fish Springs district, situated on east slope of Poverty Hills at west edge of Owens Valley, 8 miles south of Big Pine. Ore body occurs at contact of lime shale series and a monzonite porphyry. It is soft decomposed, and so fractured that the ore is easily mined and crushed. The general trend of the ore body is northward and is said to vary up to 60 feet in width. The greatest depth on it is a 150 foot shaft sunk below the present surface workings. Most of the ore milled came from open cuts west of shaft. It is stated ore averages $4 to $5 per ton in gold throughout its width. Mill capacity 250 tons, consisting of one 7″ x 16″ Sampson jaw crusher, 1 shaking screen, 1 set of Standard rolls, 1 Hardindge mill, ore from Hardindge mill passed over amalgamation plates, discharging to one roughing, and 3 Kirk concentrating tables, middlings to Diester slimer. Ore was crushed to 40 mesh. Property was operated the latter part of 1918. Operations were suspended early part of 1919, owing to low grade tenor of the ore. Owners, Buckeye Mining and Smelting Company, W. H. Noyes, president; Geo. W. Abel, secretary, La Salle Street, Chicago, Illinois.

Cinnamon Mine. Beveridge district. It is 10 miles northeast of Mount Whitney Station. Trail to mine from Mount Whitney Station. Elevation 6500 feet. Vein of quartz trends NW. and SE., dip 40 degrees, in granite. Width 2 feet. Two tunnels have been driven on the vein, upper tunnel 150 feet, lower tunnel 350 feet. Ore is reported to carry $30 per ton. Small two-stamp mill on property. Idle. Owners, F. M. Hess, and A. W. Hess, of Lone Pine, California.

Cleveland Mine. Fish Springs district. Situated 6 miles south of Big Pine, on the east slope of low granite hills which are on the western edge of Owens Valley. Series of parallel quartz veins in granite, which have a general trend east and west and dip 80 degrees south. A number of tunnels have been driven on the veins at different elevations. At an elevation of 4800 feet a tunnel has been driven 625 feet west on one of these quartz veins. The ore is free milling gold quartz with

small percentage of iron pyrite and chalcopyrite. Ore milled at small mill on Birch Creek. Property is operated off and on during the year by owner. Owner, Joseph Mear of Big Pine, California.

Cometti Group of Mines. Fish Creek district. Elevation 4500 feet. Situated 6 miles south of Big Pine, on east slope of low granite hills on western edge of Owens Valley. Holdings consist of 5 claims, with 3000 feet on the lode. Two parallel fissures cut the granite. These veins strike east and west, and dip 80 degrees south. These fissures are 6 to 8 feet in width with porphry filling in center and 12″ to 18″ of quartz on both walls. The quartz is gold bearing, and is said to carry $20 per ton. Developments consist of three tunnels driven west on the south vein. Lower tunnel is 300 feet long, winze 152 feet on vein. About 100 feet above this tunnel, is an intermediate tunnel driven west 800 feet, three shoots of ore were developed on this level 75 feet in length and about 150 feet apart, the first shoot was intersected 100 feet from portal of tunnel. These shoots of ore have been stoped out to the surface, and about 60 feet below the level. It is reported that they produced over $100,000. Five hundred feet north of main vein a cross-cut tunnel has been driven 100 feet, cutting a parallel vein, with a drift west on vein 200 feet. About one mile southeast on Birch Creek, there is a three-stamp mill.

Equipment. Blake crusher, 3 Nissen stamps. Wilfrey concentrator. Impounded in gulch below mill are 2000 tons of tailings, said to average $6 to $7 in gold per ton.

Owner, Morris Albertoli of Big Pine, California.

Kearsarge (Cliff) Mine. Kearsarge district. Situated 12 miles west of Kearsarge, a station on the Southern Pacific Railroad, on east slope of the Sierras, at an elevation of 8000 feet. Veins of quarts 6″ to 12″ wide in granite carrying gold and silver values. Developments consist of a number of shallow shafts and short tunnels. Property has been idle for over forty years. Reopened by Independent Mining Company, Independence, California, E. C. Montgomery of Independence, manager.

Iron Sides Mine. Beveridge district. It is situated 10 miles northeast of Mount Whitney Station. Elevation 8000 feet. The vein follows a limestone porphyry contact 18″ wide. Developments consist of shaft 156 feet, and tunnel 700 feet, about 2000 feet of drifts. Ore milled, stated to carry $20 to $40 per ton.

Equipment. Gasoline hoist, compressor and arrastra. Idle.

Mrs. Kate Wells of Big Pine, owner.

Nellie H. Mine. (Prospect.) Beveridge district. Situated 15 miles northeast of Owenyo, on eastern slope of Inyo Range of mountains. Elevation 8000 feet. Five claims. Vein of quartz 6″ to 24″ wide in granite. Strikes north and south, with dip 80 degrees east. Tunnel on vein 175 feet. Two men employed, on development work. A. M. Strauss and W. Ryman of Lone Pine, California.

Panamint Group of Mines. Panamint district. Situated 8 miles east of Ballarat. Holdings consist of ten claims. Considerable work has been done on the different claims, in the way of tunnels, shafts

and open cuts. There are two groups, one known as gold group, and the other as silver group of claims. On the gold group there are a series of parallel veins in the granite, while on the silver group the deposit occurs in fissures in the limestone. Deepest workings is a shaft 55 feet on the Tecopa Chief Claim. Idle. Owner, Blue Flag Gold Mining Company, 703 Exchange Building, Denver, Colorado; J. F. Erisman, president; W. B. Warren, secretary.

Pine Mountain Group. Property is situated 2 miles north of Payson Cañon on the toll road to Deep Springs Valley. Quartz vein in granite is said to average 4 feet in width and to assay $20 per ton. There are seven claims in the group. Two men employed. Chas. W. Alvord, Big Pine, owner.

Protection Group (Burro Mine). South Park district. This group of mines is situated 35 miles northeast of Trona, in Jail Canyon, at an elevation of 4000 feet. Also about 10 miles north of Ballarat. Series of parallel quartz veins in schist, with general NW. and SE. trend. Veins vary in width from 2 feet to 10 feet. Developments consist of shaft 116 feet deep, tunnel 200 feet in length, also a number of short tunnels and shallow shafts on different veins. These veins are reported to carry from $2.50 to $25 per ton in gold. Idle. H. M. Thurman, Trona, California, owner.

Washington Mine. Is situated on eastern slope of Alabama Hills, about 1 mile west of Lone Pine. A vein of quartz 4 feet in width in granite, which has a general NW. and SE. trend and dips slightly to southwest. Crosscut tunnel driven 700 feet to vein, with a drift 200 feet on vain, which gives a vertical depth at this point of 200 feet below the outcrop. Ore is said to average $20 per ton. Idle. Felix P. Meyson of Lone Pine owner.

Wilshire Bishop Creek Mine. Bishop Creek district, 22 miles southwest of Laws. Holdings consist of 12 patented mining claims, situated on the headwaters of Bishop Creek, 16 miles southwest of Bishop, on eastern slope of the Sierra Nevada Mountains at an elevation of 8500 feet. The ore body occurs in a quartzite dike which cuts the granite in N. 50° W. direction. Its dip is 60 degrees to the south. The dike averages about 800 feet in width. The lode in this dike or reef strikes N. 76° W. and dips 60 degrees north. The lode fracture has no well defined walls, the mineralization occured on lines of fracturing in the quartzite, as shown by quartz stringers in dike. The gold occurs in very fine state in quartzite, associated with iron pyrite, small percentage of arsenical pyrite and pyrrhotite. Evidently most of the gold is contained in the sulphides of iron. The ore shoot developed is about 100 feet in length and about 8 feet wide stated to average $8 to $10 per ton in gold.

The mineralized zone has been developed by means of vertical shaft 300 feet deep, with levels driven at 200 and 300 feet. On 200′ level drift west 140 feet in ore, and drift east 175 feet in ore. On 300′ level, drift west 180 feet, and a drift east 280 feet. Stoping has been carried on the 200′ level about 100 feet east of shaft. Very little stoping has been done on second level. Previous to 1920, ore treatment was by concentration, and cyanidation which proved unsuccessful.

The company is at present remodeling mill, and are planning to use the flotation process in future treatment of the mine ore. Mill equipment: No. 5 gyratory crusher. Allis-Chalmers 4′ x 6′ ball mill, Dorr classifier, oversize from Dorr classifier to 5′ x 16′ tube mill, product from tube mill to K. and K. rougher flotation machine, and 2 K. and K. cleaner machines. Mine equipment: 75-h.p. motor drives single drum hoist. 22″ x 14″ x 18″ compressor driven by 200-h.p. motor. Electric power furnished by Southern Sierras Power Company. Owner, Rocky Point Consolidated Mines Company; president, Gaylord Wilshire; secretary, H. R. Kearns; John V. Richards, manager; offices, 422 Hollingsworth Building, Los Angeles.

Bibl.: Rept. XV, p. 85.

GYPSUM.

Acme Cement and Plaster Company. Resting Springs district. Large deposit of gypsum on China or Morrison Ranch, 1 mile northeast of Acme Station on the Tonopah and Tidewater Railroad. Elevation 1500 feet. The company owns four claims known as the Gypsy Queen group. The gypsum occurs as stringers from 1″ to 2″ in thickness in clay beds. General strike of these beds is east and west, with a dip of 25 to 30 degrees north. These deposits were worked by open cut and tunnels.

Operations were suspended at the property during 1918, but there is a possibility that operations will be resumed early in 1921. Owner, Acme Cement and Plaster Company, 703 Tusco Building, St. Louis, Missouri; Samuel Lazarus, president; H. D. Walker, secretary; C. L. McDonald, West Coast agent; 509 Gasco Building, Portland, Oregon.

Bibl.: Rept. XV, p. 85.

Pacific Coast Borax Company owns an extensive deposit of gypsum in the foothills of the Black Mountains, 1 mile from Death Valley railroad. Undeveloped. Idle.

Bibl.: Rept. XV, p. 87.

IRON.

J. C. Roper and **John Amick,** of Independence, own a deposit of iron in Inyo Mountains, 7 miles east of Kearsarge Station. Ore is hematite. No production. Idle.

Bibl.: Rept. XV, p. 87.

Coso Copper Claims. Large deposits of hematite occur on the claims of Dr. I. J. Woodin, Walter Moore, and Adolph Rominger. Idle.

Bibl.: Rept. XV, p. 87.

LEAD, SILVER, ZINC.

Since the last report issued by the State Mineralogist, there has been renewed activity in the mining of lead-silver ores due to the increase in value of these metals. A large number of mines which suspended operations during the European war were reopened the early part of 1919. This proved the case in the following districts: Cerro Gordo, Darwin, and Tecopa. In the Fifteenth Report, pp. 87, 88, and the U. S. G. S. Bulls. Nos 540 and 580 A, by Adolph Knopf, a full descrip-

tion of these districts is given, so no attempt will be made by the writer except to describe those mines under operation with regard to new developments since the above reports were issued.

MINES.

Argus-Sterling Mine. (Lead-silver.) Darwin district. Situated 12 miles south of Darwin in Argus Range of mountains. Ore occurs as irregular masses in vein, which cuts the limestone. Lead carbonate and sulphate associated with iron jasper forms the vein filling material. Unoxidized ore consists of galena. Vein averages 3 feet in width. Shaft sunk on vein to depth of 155 feet, with levels at 90′ and 155′. Drift on 155′ level 245 feet, 140 feet of which is in ore. Shipment made from this ore shoot carried $110 per ton, the lead content being 47%. Six men employed. Owner, Argus-Sterling Mining Company; president, A. C. Taylor; secretary, J. A. Calder, 505 Security Building, Los Angeles.

Baxter Mine. (Lead-silver.) Resting Springs district. Four miles east of Evelyn, a station on the Tonopah and Tidewater Railroad, and on the slope of Resting Springs Mountain. Idle. Owner, J. P. Madison, Shoshone, California.

Bibl.: Rept. XV, p. 88.

Belmont Mine. (Lead-silver.) Situated in the Keeler district, 11 miles northeast of Keeler, and 3 miles by trail southeast of Cerro Gordo mine. Argentiferous quartz veins traversing a crystalline rock of granitoid texture. Ore is chiefly silver with small percentage of lead. Silver minerals contained are tetrahedrite, argentite and stephanite. Vein varies from 8 inches to 6 feet in width. Strike is N. 75° W. Dip 60° to 70° SW. Developments consist of a tunnel 400 feet and shaft 150 feet deep. There is about 3600 feet of tunnels and drifts on the property. Shipments from the mine carried $60 to $100 per ton. Property has a production of $500,000. Worked by leasers. Owner, W. L. Hunter Estate, James S. Hunter of Keeler, California, agent.

Blue Dick Mine. (Lead, silver, zinc.) Situated in Kingston Mountains, southeast of Tecopa. Idle. Owner, Henry Lang, Tecopa, California.

Bibl.: Rept. XV, p. 89.

Bunker Hill Mine. It is 35 miles northeast of Big Pine. Elevation 5500 feet. Formation is limestone. Irregular lenses of galena and lead carbonate ore occur in the limestone or on contact of limestone and porphyry. The company is developing two properties, working a crew of about 16 men at the Bunker Hill mine, sinking a shaft. Present depth is 400 feet. On the Redcliff claim, 3½ miles above the Bunker Hill, a crosscut tunnel is being driven, which is now over 400 feet in length. Owner, Inyo Bunker Hill Mines Company; president, Howard R. Link; secretary, Earl C. Peck, 421 Title Insurance Building, Los Angeles.

Carbonate Mine. (Lead-silver.) Situated in Carbonate district, 42 miles northwest of Zabriskie. Idle. Owned by Carbonate Lead Mines Company, John Salisbury, president, San Francisco, California.

Bibl.: Rept. XV, pp. 89, 90.

Cerro Gordo Mine. (Lead, silver, zinc.) Cerro Gordo district. Situated near the summit of Cerro Gordo Peak, 8 miles east of Keeler. Elevation 8500 feet. Idle. Cerro Gordo Mines Company, San Jose, California, owners.

Bibl.: U. S. G. S. Bull. 540, pp. 97-109. Prof. Paper No. 110, pp. 106-116. Rept. XV, pp. 90-92.

Chalmers Mine. (Lead-silver.) Deep Springs district. Situated 16 miles northeast of Big Pine, in Inyo Range of mountains, near Antelope Springs. Ore occurs on contact between limestone and quartz diorite. Vein 2 to 4 feet wide, strikes NW. and SE. Dip 45° SW. Ore is carbonate of lead and galena. Tunnel 70 feet in length, and an open cut on vein. Ore reported to carry high grade silver values. Idle. Sam Chalmers of Big Pine, owner.

Photo No. 29. Cerro Gordo Mine, Keeler, Inyo County; Cerro Gordo Mines Company, owner.

Christmas Gift Mine. (Lead-silver.) Darwin district, 2 miles north of Darwin. Elevation 5300 feet. Holdings consist of five claims. The country rock in the vicinity of mine consists of white lime-silicate rocks pierced by small intrusions of augite diorite porphyry. The lime silicate rocks are distinctly stratified, and strike N. 30° W. and dip 25° W. Dikes and small masses of porphyry penetrate the lime-silicate strata in the surrounding area, especially west and southwest of the mine. The vein strikes N. 40° E. and dips 75° SE. In width ranges from 2 to 8 feet, averaging 4 feet. The ore forms in irregular masses in vein. Lead carbonate and sulphate associated with iron jasper form the vein filling material. The unoxidized ore consists of galena. Fluorite, abundant elsewhere in the district, is exceedingly rare as a gangue material. Developments: Incline shaft sunk on vein to depth of 250 feet. On 250′ level a drift has been driven 200′ SW. of shaft, and at this point an incline winze has been sunk to depth of 200′, on angle of 45 degrees. At this level a drift is being driven southwest on vein, with the idea of picking up the shoot of ore that

was so productive about the 250-foot level. This shoot of ore trended to the south. The mine has produced about $550,000, all of which came from above the 250′ level and 300 feet along the vein. Ore carries 20 to 30 oz. silver, and 15 to 30% lead with $2 in gold.

Equipment, 15-h.p. gas engine hoist; 10″ x 12″ Sullivan compressor driven by 40-h.p. Fairbanks-Morse engine. Property under lease to Natural Soda Products Company, Keeler, California; W. W. Waterson of Bishop, manager. Development work is under supervision of James McIvar. Six men are employed. Owners, Christmas Gift Mining Company, L. D. Skinner, president; Mrs. Charlotte Skinner, secretary, Lone Pine, California.

Bibl.: Rept. VIII, p. 226; X, p. 211. Rept. of the Director of the Mint, Precious Metals in U. S., 1883-1884, U. S. G. S. Bull. 580-A, pp. 10-12.

Cliff Mine. (Silver.) Situated 5 miles south of Oasis, Mono County, in the White Mountains of Inyo County. Idle.

Bibl.: Rept. XV, p. 93.

Columbia Mine. (Lead-silver.) Darwin district. Idle. Owner, Darwin Silver Company, 1416 South Dearborn street, Chicago, Illinois.

Bibl.: U. S. G. S. Bull. 580, pp. 17, 18.

Custer Mine (Lead,silver,gold.) Darwin district, 1 mile east of Darwin. The ore, principally lead carbonate and galena, is found in bunches in a large irregular body of coarsely crystalline calcite. The developments consist of incline shaft 400 feet deep, with levels at 100′, 200′, 300′ and 400′. Ore recently shipped averaged 100 ozs. per ton in silver, 10% lead and $4 in gold per ton. The mine is said to have produced over $250,000 to depth of 400 feet. Four men are employed on development. Drifting on the 400′ level. The mine is under lease to Frank H. Long and Charles Grimes of Pasadena; John H. Thorndike, manager.

Bibl.: U. S. G. S. Bull. 580, pp. 15-16. Rept. XV, p. 94.

Daisy Mine. (Lead-silver.) Situated 26 miles southeast of Big Pine in the Waucoba district, on the east flank of Inyo Mountains. Elevation 7575 feet. Idle. Owners, Hercules Mining Company, Wallace, Idaho.

Defiance Mine. (Lead-silver.) Darwin district. Recently purchased by Darwin Silver Company, 1416 South Dearborn street, Chicago, Illinois. The company is planning to reopen and develop the mine. It is reported that there is a large tonnage of ore in the mine that will carry 8 to 10 ozs. silver with 12% lead. The ore body occurs as irregular lenses of lead carbonate on contact of diorite and lime-silicate rock. The ore body is 20 to 40 feet thick. On the hanging wall, which was the ore that was stoped, the ore occurred as galena in heavy calcite, below the footwall is lead-carbonate ore with some galena. Developments consist of incline shaft sunk on an angle of 35 degrees to development of 380 feet, at bottom of incline on fifth level a winze was sunk 100 feet in ore. Four men employed. A. G. Kirby, manager.

Bibl.: Report of the Director of the Mint, Precious Metals in U. S., 1883-1884. Repts. VIII, p. 226; X, p. 211; XII, p. 24. U. S. G. S. Bull. 580-A.

Estelle Group of Mines, Cerro Gordo district, are 5 miles east of Keeler, on western slope of Cerro Gordo Mountain. Holdings consist of 11 claims. Ore bodies consist of lenticular masses of lead-carbonate ore, the ore being enclosed in marbleized limestone. The ore is principally reddish yellow lead-carbonate and galena. Troeger tunnel has been driven 7300 feet, crosscutting the limestone formation with the idea of cutting the San Felipe vein 2500 feet below the Cerro Gordo mine.

In driving the tunnel the following veins were cut: West Contact, Jefferson, Union and Bull Run, all of which were productive on the surface but in the tunnel showed very little ore. Tunnel which is driven N. 60° E. intersects carboniferous rocks, mainly limestone, a considerable number of fault zones have been encountered, most extensive being 200 feet wide. About 500 feet remains to be driven to strike the San Felipe or Morning Star vein. At 5500 feet from portal of tunnel, cut wide belt of carboniferous slates which dip 50 degrees west. A series of monzonite intrusions were also cut, so far only one small shoot of ore was developed in tunnel. A few quartz veins cut contained tetrahedrite, galena sphalerite and pyrite, said to carry 10 to 20 ozs. silver. The veins strike N. 35° W. to N. 45° W., with dips varying from 50° to 80° southwest. The only development being done is on the Morning Star claim. The mine is situated at an elevation of 8000 feet. Developments consist of a crosscut tunnel driven N. 40° E. 450 feet, where cut ore deposit. Winze sunk on ore to depth of 225 feet, with levels at 40′, 70′, 120′ and 220′. Ore forms in series of chamber deposits 12′ to 40′ wide. Strike N. 30° W., dip 75 degrees west. Heavy galena and carbonate ore being mined, carrying 35 ozs. silver, 10 to 12% lead with gold values. Ore is transported over an aerial tramway 7000 feet long to terminal below Troeger tunnel. From terminal bins loaded in trucks and hauled to Keeler. Shipping 20 to 30 tons per day to smelter at Midvale, Utah. Twenty men are employed. Owner, Estelle Mining Company; president, R. C. Troeger; secretary, A. H. McAdoo; R. C. Troeger, Jr., superintendent.

Bibl.: Adolph Knopf, U. S. G. S., Bull. 540, p. 110. Rept. XV, pp. 108-109.

Gibraltar Mine. (Lead-silver.) South Park district, southeast of Ballarat, in the Panamint Mountains. Elevation approximately 7000 feet. Idle. Owned by Domingo and Clairen, Ballarat, California.

Gunsite Mine. (Lead-silver.) Resting Springs district, 7 miles east of Tecopa. Elevation 2350 feet. Spur track of the Tonopah and Tidewater Railroad to the mine from Tecopa. The country rock is dolomite, overlying quartzite. The ore occurs in irregular lenses along a fissure in the dolomite. Strike N. 45° W., dip W. 35° to 50° E. Width of ore bodies 20 to 30 feet. The ore is principally carbonate of lead, with some galena. The vein matter is decomposed lime with iron oxides. Developments consist of incline shaft sunk to depth of 1000 feet. Crosscut tunnel 800 feet to vein, with drift south 900 feet on vein. Then winze sunk from this level (7th level) to the 1000-foot level. The ore that averages 15 to 20% lead, and 6 to 10 ozs. silver, shipped to smelter of American Smelting and Refining Company, Garfield, Utah. Ore running from 3 to 6 ozs. silver and 5% lead goes to

concentration plant at Tecopa. All mining is done by hand. Fifteen men employed. Adjoins the Noonday Mine, owned and operated by the same company.

Owners, Tecopa Consolidated Mining Company, L. D. Godschall, vice president and general manager.

Bibl.: Report of the Director of the Mint, Precious Metals in U. S., 1883, p. 166. Rept. XV, pp. 95-96.

Ibex Mine or **Arcturas.** (Lead, silver, zinc.) Situated in the Black Mountains, 16 miles southwest of Zabriskie and 6 miles north of Saratoga Springs. Elevation 1300 feet. Idle. Owner, Ibex Spring Mining Company; president, J. F. Kent; secretary, C. W. Kent, 431 Security Building, Los Angeles, California.

Bibl.: Report XV.

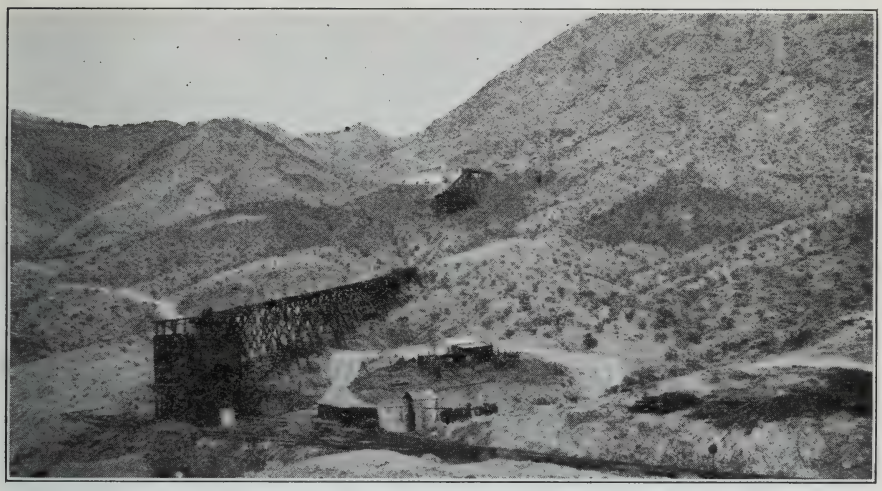


Photo No. 30. Gunsite Mine, Tecopa Consolidated Mining Company, Tecopa, Inyo County. View of workings, tramway and loading bins.

Ignacio Mine. (Lead-silver.) Cerro Gordo district, 6 miles east of Keeler. Elevation 7800 feet. Idle. Ignacio Mining Company; president, P. M. Price, San Diego, California.

Bibl.: R. W. Raymond, Mineral Resources West of Rocky Mountains, 1870, p. 17. Rept. XV, pp. 97-98.

Independence Mine. (Lead-silver.) Darwin district; adjoins the Defiance mine. The ore body is situated at the contact of lime-silicate rocks with quartz-diorite, which is the northward extension of the belt forming the footwall of the Defiance ore deposit. The most interesting feature of the Independence ore body is the fact that the galena and its alteration products are in a garnet gangue. Ore is a carbonate of lead, carried 12 to 15% lead, 6 to 8 ozs. silver. Trend of ore body is N. 45° W., dip 25° SW. 6 to 12 feet thick. Developments consist of two tunnels, upper tunnel 200 ft., lower tunnel 150 ft. Reported a large tonnage of ore developed. Recently purchased by Darwin Silver Com-

pany, 1416 South Dearborn street, Chicago, Illinois. A. G. Kirby, general manager.

Bibl.: Report of Director of Mint, Precious Metals in U. S., 1883, p. 1 4, 1884, p. 103. State Mineralogist Repts. VIII, p. 226; X, p. 211. U. S. G. S. Bull. 580, pp. 14, 15.

Jackass Mine. (Lead-silver.) Darwin district; is 1 mile northeast of Darwin; adjoins the Lane mine. Contact metamorphic deposit, mineralized zone 45 feet wide in lime silicate rocks. The zone strikes NW. and SE., dips 70 degrees southwest. Ore is galena, carbonate of lead with some sphalerite. Ore carries 12 to 15 ozs. silver and 4 to 6% lead. Some high grade ore has recently been shipped from the mine. Mine developed by incline shaft to depth of 140 feet, with drifts north and south on the vein. Elevation of shaft is 5000 feet, about 900 feet

Photo No. 31. Eastern slope of Darwin Hills. Showing location of Jackass, Custer and Defiance Mines, Darwin, Inyo County.

above Lane mill. Ore is transported over aerial tram to mill in ½-ton buckets a distance of 2500 feet.

Mill has been leased from the Darwin Silver Company. Mill 4″ x 6″ Ball mill, one K. and K. flotation machine, one Diester table. An 80-h.p. gas engine furnishes power to run mill. Company plans to treat ore by flotation and concentration. Six men employed. Owner, Black Metal Mining Company; president, J. J. Seaman; S. E. Porter, secretary, 630 H. W. Hellman Building, Los Angeles, California; J. J. Seaman, manager.

Lane Mine. (Lead-silver.) Darwin district, 2 miles northeast of Darwin on east flank of Darwin Hills. Elevation 4100 feet. Idle. Owners, Darwin Silver Company, 1416 South Dearborn street, Chicago, Illinois; A. G. Kirby, general manager.

Bibl.: Repts. XII, p. 24; XIII, p. 32; XV, pp. 98-99. U. S. G. S. Bull. 580-A.

Lee Mine (Emigrant Mine). (Lead, silver, zinc.) Lee district, east of Cerro Gordo, 26 miles from Keeler. Idle. Owned by Dr. I. J. Woodin and William Skinner of Independence, California.

Bibl.: Report of Director of Mint, Precious Metals in U. S., 1883, p. 163. Rept. XV, pp. 99-105.

Lincoln Mine. (Silver.) Deep Springs district. Situated 25 miles northeast of Big Pine, and about 4 miles north of Deep Springs ranch, on the Midland trail. Elevation 6200 feet. Holdings consist of 10 claims. Series narrow fissure veins, with widths varying from 6″ to 12″, cutting granite. These veins strike east and west with dip of 65 degrees north. Some ore sorted and shipped from the property during the early part of 1920, is reported to have carried 100 ozs. silver per ton. Developments consist of three shafts sunk on the veins to depths of 75 to 100 feet, also a number of short tunnels. The discovery of high

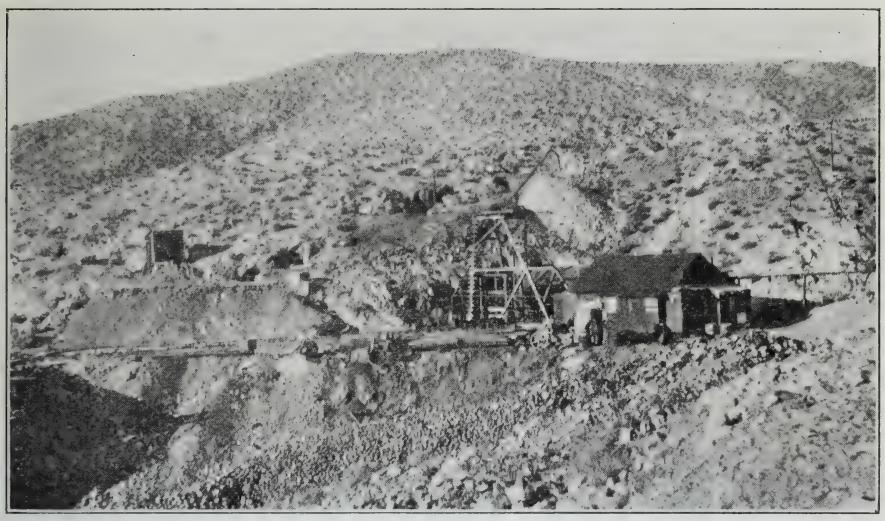


Photo No. 32. Lucky Jim Shaft, Darwin Silver Company, Darwin, Inyo County. View shows outcrop and workings on vein.

grade silver ore on this property caused some excitement and a large amount of the surrounding country was located. Idle. V. Richardson, Gustave Hansen, Magines Strand of Big Pine, owners.

Lucky Jim Mine. (Lead-silver.) Darwin district, 2 miles north of Darwin; adjoins the Christmas Gift mine, 24 miles southeast of Keeler. The country rock is limestone with intrusions of monzonite. The vein cuts across the lime beds striking N. 50° E. and dipping 65 to 80 degrees west. The consists principally of the oxidized ores of lead carrying silver values. Galena occurs in bunches in the vein. Vein is 4 to 6 feet wide. Ore carries 10 to 12 ozs. silver and 6 to 8% lead. The mine is operated by a 300 foot vertical shaft. On 300′ level 515 feet SW. of shaft an incline winze 450 feet deep to 750 foot level. Two well defined faults were cut south of Lucky Jim shaft; these faults strike N. 45° W., dip 80° SW. and are parallel; they are about 500 feet apart.

On 200′ level struck No. 1 fault 500′ south of shaft. Vein faulted 63 feet south. On 300′ level cut fault 515′ from shaft. Vein being faulted 63 feet to SE., a drift was driven on fault 300 feet to northwest. Incline winze sunk on fault 300′ level to 400′. On 500′ level cut main vein 265 feet SW. of winze, showing ore shoot 10′ to 20′ wide, ore carries 25 ozs. silver, 12% lead. No. 2 fault was cut on 500′ level 365′ south of winze, the vein being faulted SE. 40 feet. Ore shoot developed at this point 240′ long, vein dips 80 degrees NW., has a width of 4 feet. On 650′ level cut a cross vein striking N. and S. dips 50° W., showing 2 feet of ore. All ore shoots have a general trend to SW. of 30 degrees. Footwall vein intersects main vein on 750′ level.

The mine is being extensively developed under the supervision. A. G. Kirby, manager, and the plans of the company are to install a concentration plant to treat the ores from this mine, also from Independence and Defiance properties.

Equipment. At Lucky Jim shaft, 25-h.p. gas engine hoist; at winze on 300′ level, 25-h.p. electric hoist. Central power plant equipment: 100-h.p. 2-cyl. Semi-Diesel-Fairbanks Morse engine; 25-h.p. Auxiliary Fairbanks Morse gas engine; 2-Way Ingersoll-Rand compressor cylinders (15″ x 12″, 9″ x 12″), 25-h.p. electric generator, 2 Duplex trucks. Company owns water line from Coso Mountains to Darwin, a distance of 8 miles. All water for plant and domestic use hauled by trucks from town of Darwin. Mine was reopened during January, 1920. The total production of this mine is $1,500,000.

Owners, Darwin Silver Company; president, E. W. Wagner; secretary, E. N. Schroth, 1416 South Dearborn street, Chicago, Illinois; A. G. Kirby, general manager; A. A. Belin, superintendent.

Bibl.: Mining Resources West of Rocky Mountains, 1876, p. 25; Report of Director of Mint, Precious Metals in U. S., 1883, p. 163. State Min. Bur. Repts. VIII, p. 226; X, p. 211; XII, p. 24; XV, pp. 100-101. U. S. G. S. Bull. 580, pp 12, 18.

Minneatta Mine. (Lead, silver, zinc.) Located in the Lookout district 28 miles north of Trona. East slope of Argus Mountains. Elevation 3000 feet. Idle. Owned by J. J. Gunn, Independence, California.

Bibl.: R. W. Raymond, Mining Resources West of Rocky Mountains, 1876, p. 32. Rept. X, p. 212.

Modoc Mine (Lead-silver.) Lookout district, 30 miles north of Trona, 2 miles north of Minneatta mine. Elevation 3500 ft. Idle.

Bibl.: Repts. XII, p. 24; XIII, p. 32. Report of Director of Mint, Precious Metals in U. S., 1883, p. 164; 1884, p. 104.

Monster Mine. (Lead-silver.) Situated on east slope of Inyo Mountains, northwest of Saline Valley. Located in 1907. Idle. Owners, Frank Butler and Sam Watson of Big Pine, California.

Bibl.: Adolph Knopf, U. S. G. S. Bull. 540, p. 111.

Montezuma Mine. (Lead-silver.) Situated 10 miles southeast of Big Pine on the western slope of the Inyo Range. Elevation 4700 feet. The country rock is limestone and slates, which have been greatly shattered and faulted. Ore forms in irregular lenses along a fault between the limestone and clay slates. Ore is of argentiferous galena, lead carbonate, enclosed in iron oxide. Content varies from 12 to 18% lead, with 12 to 10 ozs. silver. Developments consist of three crosscut tunnels: Lower tunnel 1400 feet, Intermediate 400′, Upper 200′. Most ore shipped has come from two upper tunnels. Expect to cut ore body shortly in lower tunnel, which will give 514 feet of backs. Sulphide ore body developed on upper tunnel level is 30′ wide and 50 feet in length carrying 14 ozs. silver with 6 to 10% lead. Carbonate ore body developed between intermediate and upper tunnel 200′ long by 50′ wide with values of 8 to 10 ozs. silver and 8% lead. Shipping ore from these workings.

Mine equipment, Sullivan compressor; 50-h.p. semi-Diesel gas engine. Mill, Blake crusher, Marcy ball mill, 4 Wilfley tables, K. and K. flotation machine; 25-h.p. gas engine.

Owner, Montezuma Mining Company; president A. W. Hildebrand; secretary, W. F. Ainsworth; No. 1 Broadway, New York City, New York. Henry Mitchell, manager.

Bibl.: Report of Director of Mint, Precious Metals in U. S., 1883, p. 158; 1884, p. 100; State Min. Bur. Rept. XIII, p. 32. U. S. G. S. Bull. 540, pp. 109, 110. State Min. Bur. Rept. XV, p. 102.

Nancy Hanks. (Lead-silver.) Located in the Waucoba district, 28 miles by road southeast of Big Pine, on east flank of Inyo Mountains. Elevation 8250 feet. Idle. Owned by George B. Warren of Big Pine, California.

Bibl.: Rept. XV, p. 102.

Noonday and Grant Mines. (Lead, silver, zinc.) Located in Resting Springs district, 9 miles southeast of Tecopa and 2 miles southeast of the Gunsite mine. Elevation 2880 feet. Spur track of the Tonopah and Tidewater Railroad to mine from Tecopa. The deposit is a continuation of Gunsite vein, striking N. 40° W., dip 45° NE. Main ore bodies are formed along a series of parallel north and south fault fractures in dolomitic limestone. Ore is carbonate of lead with some unoxidized galena. Average ore mined carries 3 ozs. silver and 4 to 5% lead. Zinc carbonate ore found in upper levels. Developments consist of incline shaft sunk on angle of 45 degrees to depth of 400 feet. Ore hoisted through this shaft from lower workings. Main tunnel (200′ level) driven south 1800 feet through hill. About 600 feet south of shaft on this level, a winze has been sunk on incline to depth of 250 feet. At depth of 200 feet in this winze ore was cut off by fault slip, which dips 45 degrees west. This ore body has recently been picked up about 50 feet above this level. Ore reported to carry high silver and lead values. Ore hoisted from winze by 15-h.p. gas engine, then trammed to ore pocket in main shaft on tunnel level. Hoisted by 20-h.p. gas engine. Ore carrying values of 8 to 10 ozs. silver and 15 to 20% lead shipped to American Smelting and Refining Company's Smelter at Murray, Utah.

Second class ore, 4 to 5% lead and 4 to 6 ozs. silver goes to concentration plant at Tecopa. Thirty-five men are employed at mine.

Mill capacity 100 tons per day. Treating 60 tons.

Flow sheet, 200-ton Blake crusher driven by 20-h.p. gas engine. Ore from crusher conveyed by belt conveyor to mill bins. From bins ore passes over Colorado impact screen and screened to 8 mesh. Oversize

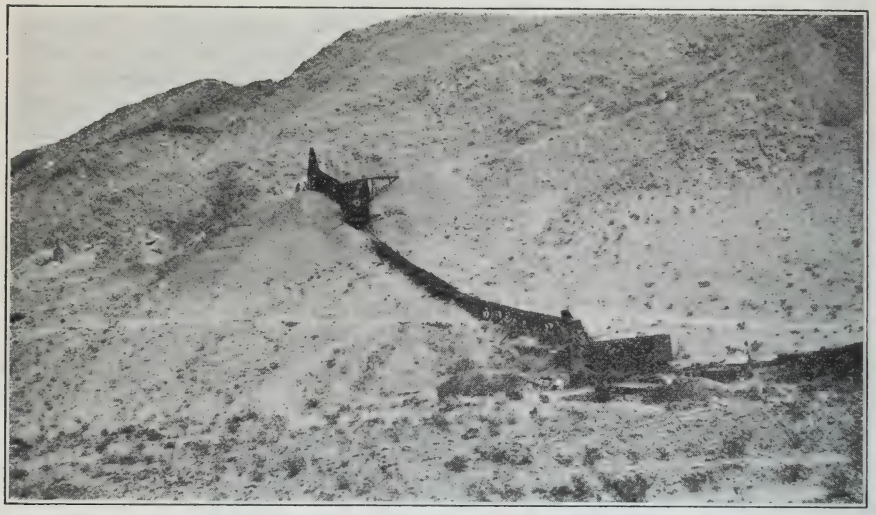


Photo No. 33. Noonday Mine, Tecopa Consolidated Mining Company, Tecopa, California.

goes to 4″ x 6″ Ball mill, while through size (8 mesh) goes to main launder. Oversize reground in ball mill to pass through 8-mesh screen, then to 3. Richards hydraulic classifiers, where classified so that approximately 40 tons of 8 to 12 mesh material treated by Bert-chart table, and material from 20 mesh to slimes by 6 Wilfley tables. Overflow from classifiers to 8-foot callow cone. Spigot product from cone to No. 6 Wilfley table, overflow from cone used as wash water. Mill making a recovery of 85%.

Photo No. 34. 100-Ton Concentration Mill, Tecopa Consolidated Mining Company, Tecopa, California.

Approximate average anaylsis of ore treated:

Au.	Ag.	Pb.	Insol.	Fe	CaO	S.	Mg O and Magnesia
.045 ozs.	5.9 ozs.	4.7%	5.1%	9.15%	22.15%	.3	20–30%

Concentrates produced being 10 to 15 tons per day, carrying 22 ozs. silver and 26% lead. Mill driven by 50-h.p. semi-Diesel Fairbanks-Morse gas engine. six men employed in mill. Owners, Tecopa Consolidated Mining Company; L. D. Godschall, vice president and general manager; William Godschall, superintendent.

Bibl.: Rept. XV, pp. 103, 104.

Opal Mine. (Lead-silver.) Waucoba district, 26 miles southeast of Bishop, and adjoining Daisy mine. Idle. Owned by Walter Bird and Russel Steward, Big Pine.

Bibl.: Rept. XV, p. 104.

Ophir Mine (Lead, silver, zinc.) Situated 10 miles northeast of Trona, at the base of the Slate Range. Idle. Owners, T. Thorkildsen and T. H. Rosenberg, 320 Trust and Savings Building, Los Angeles.

Paddy Pride Mine. (Lead-silver.) Situated 9 miles west of Zabriskie, a station on the Tonopah and Tidewater Railroad in limestone hills at southern end of Funeral Range of mountains. Holdings consist of 5 claims. Irregular lenticular deposits of lead-carbonate ore in limestone.

General strike of vein is NW. and SE.; dip of 60° to 70° SW. Width of vein 4 feet to 8 feet. Developments consist of a tunnel 150 feet in length. A lower tunnel is being driven that will cut the vein at a depth of 500 feet below outcrop. Two carloads of ore have been shipped from property assaying 0.10 ozs. gold, 24.4 ozs. silver, and 45% lead. Six men are employed. Owner, Paddy Pride Silver Mining Company; president, John T. Overbury, Tecopa, California.

Pennsylvania Mine. (Lead-silver.) Swansea district. Situated 3½ miles northwest of Keeler, on western slope of Inyo Range of mountains, at Swansea. Elevation 4000 feet.Irregular bunches of galena and lead carbonate in fissure in limestone. Vein strikes N. 30° W. and dips 38 degrees east. Width of vein 8″ to 2′. Shaft 150 feet deep, also number of shallow shafts and short tunnels on different claims. Ore stated to assay from 20 to 90 ozs. silver and 12 to 50% lead. Four men employed in sinking the shaft. Owner, Pennsylvania Mining Company; president, A. A. Irish, Grosse Building, Los Angeles, California; George A. Hill, superintendent.

Raven Mine. (Lead-silver.) Ubehebe district, 60 miles southwest of Bonnie Claire, Nevada, and 5 miles north of Dodds Springs. Elevation 3800 feet. Idle. Owned by J. Crook and A. Farrington of Big Pine, California.

Bibl.: Rept. XV, p. 106.

Redwing Mine. (Lead and zinc.) Resting Springs district, 4 miles northeast of Shoshone, on west slope of Resting Springs Mountain. Idle. Owned by R. J. Fairbanks of Shoshone, California.

Bibl.: Rept. XV, p. 106.

Royal Group (Spear Mine). (Lead, silver and zinc.) Cerro Gordo district, 1 mile north of Cerro Gordo mine, along top of ridge 8 miles east of Keeler. Elevation 8400 feet. Idle. Owned by R. C. Spear of Lone Pine, California.

Bibl.: Rept. XV, p. 106.

Rip Van Winkle Group. (Lead-silver.) Darwin district, 1 mile north of Darwin, adjoining Independence and Defiance mines. Vein strikes NE. and SW. Dip 45° to 80° N. Formation limestone. Ore, lead-carbonate with occasional bunches of galena, with gangue of spar and calcite. Shipping ore that runs about $100 per ton. Mine worked through 250-foot shaft with levels at 100′, 150′ and 200′. Winze from 200′ level 150 feet deep in ore. Equipment, 15-h.p. gasoline hoist. Three men employed. Owner, M. J. Summers of Darwin, California.

Santa Rosa Mine (Lead-silver.) Lee district, east of Cerro Gordo, and 26 miles by road from Keeler. Elevation 7000 feet. Six men leasing on property. William Parr, superintendent; owners, Independent Lead Silver Mining Company, Syndicate Building, Oakland, California.

Bibl.: Rept. XV, pp. 107-108.

Silver Reef Mine. (Lead-silver.) South Park district, 6 miles east of Ballarat, near summit of Panamint Range. Idle. Owner, J. A. Gilliam, Ballarat, California.

Bibl.: Rept. XV, p. 108.

Swansea Chief Mine. (Lead-silver.) Cerro Gordo district. It is situated 4 miles northeast of Keeler, on southwest slope of Inyo Range of mountains. Elevation 4600 feet. Two claims: Swansea Chief and Swansea Chief No. 1. Lead carbonate ore with occasional bunches of galena, occurs in lenses along a north and south fissure in limestone. Also at a point of intersection of this north and south fissure with an east and west fissure. Vein 2 to 4 feet wide. Developments consist of incline shafts sunk on north and south vein to depth of 150 feet. Ore is stated to carry 20 ozs. silver and 8 to 10% lead. Idle. Owner, Inyo Cerro Gordo Mines and Power Company; C. H. Berryhill, secretary, San Jose, California.

Ubehebe Mine. (Lead-silver.) Ubehebe district, 52 miles by road southwest of Bonnie Claire, Nevada. Elevation 3930 feet. Idle. Arch Farington of Bishop, California, owner.

Bibl.: Rept. XV, p. 109.

Utacala Mine. (Zinc.) Darwin district. Situated 9 miles northeast of Darwin, on the north end of the Argus Range of mountains. Large deposit of zinc carbonate ore occurs along a north and south fracture in the limestone. Deposit is from 8 to 10 feet wide. Stated to assay from 40% to 45% zinc. Ore calcined at the mine and then hauled 34 miles to Keeler. Six men are employed on development work. During 1918 the mine was one of the largest producers of zinc ore in Inyo County. Was operated part of the time by Western Ore Purchasing

Company of Reno, Nevada. Owners, Utacala Exploration Company; president, J. Kirk; secretary, C. P. McDonald, Newhouse Building, Salt Lake, Utah.

Ventura Mine. (Lead-silver.) Cerro Gordo district, 6¼ miles by road east of Keeler. Situated on western flank of Inyo Mountains, below Cerro Gordo mine. Elevation 7800 feet. Idle. Owners, Ventura Mining Company of New York.

Bibl.: Rept. XV, p. 110.

MARBLE.

The marble deposits of Inyo County occur on the southwestern flank of the Inyo Range and extend for 6 miles northeastward from Swansea Station. The marble outcropping along the base of this range shows a thickness of at least 500 feet. The beds are tilted at a high angle, dipping northwestward into the mountain. The marble is dolomitic, fine grained and hard. The quarries which have been opened represent only a fractional portion of the material which extends both northwest and southeast for several miles, and which have been undeveloped. About three miles south of Inyo quarries, and about half a mile southeast of Swansea, shows a vertical stratum of pure white dolomite marble, estimated to be over 100 feet in thickness. The white marble beds extend from here to the northeast of Inyo quarry, some three miles, but they are much shattered by cross faulting in places. The marbleized beds are of vast thickness and continuity, both in depth and extent. Four varieties of marble are found, a pure white marble, a beautiful yellow marble and a variegated marble of white ground mass, penetrated by dendridic markings of manganese. Chemically these marbles are a very pure dolomite, close grained and compact, and equally well adapted for exterior and interior work.

Inyo Marble Company, president, D. H. Dunn; secretary, Robert H. Tune; offices 1014 Hibernian Building, Los Angeles, California, have filed locations on twenty-four 160-acre claims, along the total length of marble outcrops; including the property of the Old Inyo Marble Company. Installing machinery for sawing and polishing marble, which is to be shipped to Minneapolis. Warehouses and spur track have been built to property. Six men employed. L. H. Dapprich, superintendent.

Bibl.: Repts. X, 215; XII, 392; XIII, 628; Bull. 50, pp. 99, 100. Mining and Scientific Press, July 20, 1912. Rept. XV, p. 111.

MOLYBDENUM.

Lucky Boy Prospect. Union district, 7 miles east of Kearsarge Station on the east flank of the Inyo Mountains. Elevation 7000 feet. Molybdenum occurs scattered through a quartz vein along contact between granite and limestone. H. M. Myers and J. E. Brown of Independence, California, owners.

Occurrence of molybdenite is reported by **F. A. Campbell** of Lone Pine on the upper part of Lone Pine Creek. The molybdenite occurs as small flakes in quartz gangue.

Pine Creek Molybdenum Deposit. The deposit is situated 45 miles by road northwest of Laws Station, on the south slope of Mount Morgan in Sierra Nevada range of mountains at an elevation of 11,200 feet. High grade stringer of molybdenite ore occurs on contact of granite hanging wall and the tungsten ore body, striking N. 50° E., and standing almost vertical. The stringer is 6″ to 8″ wide, and the molybdenite is disseminated in the footwall to a depth of 3 to 4 feet. The rich stringer runs as high as 95% molybdenite. Two hundred pounds were sacked from this stringer, said to have average of 90%. The deposit was developed in a small way incidental to mining the tungsten deposit. Idle. Owner, Pine Creek Tungsten Company; president, E. Cooper Shapley; secretary, H. M. Pancost, Philadelphia, Pennsylvania.

NITER.

The niter beds are situated in the southeastern part of Inyo County, extending across the boundary line into northern part of San Bernardino County. The principal deposits are known as the Confidence Beds, situated along the south side of Death Valley at the "narrows" northwest of Saratoga Springs. Owners, California Nitrate Company, 40 California street, San Francisco.

The Upper Canon Beds. Resting Springs district. Situated along both sides of the Amargosa River on the Morrison Ranch and extending into San Bernardino County. Owned by the Pacific Nitrate Company, Consolidated Realty Building, Los Angeles.

Bibl.: Bull. 24, 165-174. "The Saline Deposits of California," issued by California State Mining Bureau. Rept. XV, pp. 117-119.

PUMICE.

Deposits of pumice reported 6 miles northeast of Little Lake. C. W. Wicklund of 540 South Hope street, Los Angeles, California, has located a number of claims, also shipped a number of cars in early part of 1920. Hauled by wagon to Marble siding on Tonopah and Tidewater Railroad.

POTASH.

The production of potash on a commercial basis from the waters of Owens Lake in Inyo County is contemplated by Natural Soda Products Company, and the California Alkali Company. These companies are operating soda plants on the shores of Owens Lake. Potash also occurs in small amounts in the saline deposits of Death Valley, Saline Valley and Deep Springs Valley. These deposits are fully described in U. S. G. S. Bulls. Nos. 540, 580.

Inyo Chemical Company, Detroit, Michigan. Planning to install a plant at Deep Springs Valley Lake for extraction of soda and potash from the lake brines. Ten men employed on construction, and in hauling material and supplies for plant. Charles Trumble, superintendent; home office, Big Pine, California.

SALT.

Sodium chloride is deposited as a major ingredient in the saline crusts of Death Valley, Saline Valley, and Salt Wells Valley, and in the waters of Owens Lake. It occurs in smaller amounts in the niter beds that border the Amargosa River. The only production in the county is now from the Saline Valley deposits.

Bibl.: Bull. 24, "The Saline Deposits of California."

Owens Valley Salt Company's Deposit. It is 12 miles in airline northeast of Swansea, where company's mill is situated. The deposit is in the lowest depression of Saline Valley. The deposit is worked during the summer months, and a sufficient supply is harvested to operate the mill during the year. Under lease to Taylor Milling Company, 1520 San Fernando road, Los Angeles, California; G. W. Russell, superintendent.

Bibl.: U. S. G. S. Bull. 540, pp. 416-420.

Photo No. 35. Bed of silica 8 feet thick near Shoshone, Inyo County. Associated Oil Company's deposit. Photo by T. P. Henderson.

SILICA.

Shoshone Silica Deposit. The deposit is situated ¼ mile west of Shoshone, a station on the Tonopah and Tidewater Railroad.

Holdings consist of two placer claims, 320 acres, recently purchased from R. J. Fairbanks of Shoshone. Elevation 1,700 feet. In low hills on the western edge of Amargosa Valley, beds of silica 8 feet thick occur in the Pleistocene sediments. The deposit has been developed and prospected by a series of pits. Its extent has been proven 1,000 feet in north and south direction, and about 800 feet in an eastern direction. In working, the deposit is first stripped of its clay overburden, which is from 2 to 10 feet thick. Material is sacked and shipped to the Associated Oil Company's refining plant. It is used for filtering and puri-

fying oils. Twenty men employed. Owners, Associated Oil Company, San Francisco, California.

Lucky Boy and Separator Silica Deposit. Lies north of the Shoshone deposit. Beds of silica 6 feet thick, strike north and south. Overlain by clay overburden. A number of openings have been made on the outcrop. Holdings consist of 280 acres. It is estimated there is 50,000 tons of the material. Owners, W. S. Baylis and associates of Los Angeles, California.

SODA.

The only soda produced in the county is derived from the waters of Owens Lake. This lake lies between the Sierra Nevada Mountains on the west and the Inyo Range on the east and has no outlet. It covers an area of 97.2 square miles. The water is a dense brine, containing common salt, soda, borax and other soluble salts. These soluble salts were evidently derived by the slow accumulation and concentration of the waters of the Owens River, which enters the basin from the north. Three plants are under operation on the shores of Owens Lake extract-

Photo No. 36. View of Owens Lake and California Alkali Company's Soda Plant, Cartago, Inyo County, California.

ing the soda from the lake waters. The capacity of two of these plants have been greatly increased during the past year, and are operating to capacity.

California Alkali Company. The plant is situated at Cartago, a station on Owenyo branch of the Southern Pacific Railroad, on the western shore of Owens Lake. Plant has been in continuous operation since September, 1917. Producing about 100 tons daily of dense soda ash.

Process. Lake water is concentrated in clay vats by solar evaporation, and the concentrated brine pumped into eight large wooden tanks. Carbon dioxide generated from dolomite is passed through these cylindrical tanks, precipitating the soda. The latter is drawn from the bottom of the tank, passed through filters, then introduced into rotary furnaces, where the material is thoroughly dried. Subsequently it is introduced into a large brick furnace, resembling a muffle kiln, to reduce it to the carbonate. An air blast at the furnace discharge cools the ash, which is then conveyed to rolls and pulverized. Sacked and stored in warehouse for shipment. One hundred men are employed. Owners,

California Alkali Company; president, Mortimer Fleishhacker; Secretary, John F. Bush; John F. Bush, vice president and general manager.

Chemical Production Company. Plant is situated 9 miles south of Lone Pine, on west shore of Owens Lake, north of California Alkali Company's plant. Plant has a capacity of 20 tons of soda ash per day. Plant operated two months in 1918, but process proved a failure. Idle. Owners, Chemical Production Company; president, Lafayett M. Hughes, 612 Majestic Building, Denver, Colorado.

Inyo Development Company. The plant is situated 1 mile northwest of Keeler, on the eastern shore of Owens Lake. Plant recently purchased by the California Alkali Company.

Process. The lake water is pumped into large clay vats, varying in size from one acre to 20 acres, to a depth of from 6″ to 8″. It is concentrated by solar evaporation until the carbonates are precipitated. Trona harvested once a year, in crust about ¾″ thick. Introduced into oil burning furnace where bicarbonate is reduced. After leaving furnace is carried by conveyor to a Williams rolls, where it is pulverized and sacked for shipment. Producing 20 tons of soda ash per day. Employ 20 to 150 men. J. S. Hunter, superintendent.

Bibl.: Repts. VIII, p. 226; XII, p. 409; XIII, p. 646; XV, p. 124-125.

Natural Soda Products Company. Plant situated on east shore of Owens Lake, 2 miles south of Keeler. This company is producing bicarbonate of soda, as well as soda ash, and shipping 10,000 tons of trona yearly. Plant capacity has been increased to 120 tons of dense soda ash per day.

Process. Water from lake evaporated in large solar tanks until a concentrated solution is obtained, then pumped to two 1000-gallon settling tanks, from which it is pumped into four 16-feet diameter and seventeen 8′ diameter carbonator tanks. Carbon dioxide generated by burning dolomite in four carbonate towers (40′ high by 8′ diam.) is passed up through the bottom of these tanks under pressure, which are divided by 8 screens to break up the CO_2 and and precipitates Na CO_3. The CO_2 cooks the solution, changing it from mono-carbonate to bicarbonate of soda. The soda is drawn from bottom of tanks and filters through two Oliver filters. Fresh water being sprayed on cake to remove Na Cl which is soluble. From filters material goes to nine 12′ x 25′ Hill furnaces (capacity 20 tons each) reduced to soda ash. The soda ash ground in two Williams swing-hammer pulverizers. Sacked or placed in barrels for shipment. Recently the company has made large shipments of soda ash to Japan and Sweden.

Power plant equipment. Two 80-h.p. boilers, five 18″ x 12″ Gardner compressors; three batteries of Nash hydro-turbine vacuum pumps, driven by one 100-h.p. motor and one 150-h.p. motor. Compressors are driven by 110-h.p. motors. Total horsepower of plant is 2,230. One hundred men employed. Owners, Natural Soda Products Company; president, W. W. Waterson; secretary, J. S. Henderson; Paul Waterson, superintendent, Keeler, California.

SULPHUR.

Small deposits of sulphur are reported 1 mile southwest of Coso Hot Springs and in the mountains east of Big Pine.

Deposits of sulphur are also reported on the west slope of Last Chance Range of Mountains, 10 miles southeast of the Loretta Copper Mine.

Sulphide Sulphur Group of Claims. Situated on west slope of Lookout Mountain in Last Chance Range of Mountains and 10 miles southeast of Loretta Mine. Sulphur deposited in fractures in limestone. Outcrop reported to be 30 feet wide. Sulphur content stated to be 96%. Developments consist of series of open cuts at different points along outcrop. Owner, James Jacoby, 2364 Birch street, Denver, Colorado.

Sunshine Sulphur Mine. Situated 13 miles due east of Loretta Mine, in Last Chance Range of Mountains. Sulphur deposited in fissures in limestone. Reported to be 5 feet thick and several hundred feet in length. Samples taken reported to run 98%. Owned by W. H. Murray and associates, 921 Wright-Callender Building, Los Angeles, California.

TALC.

California Mineral Corporation Talc Deposit. The deposit is 8 miles southwest of Zabriskie. The talc is pure white, occurring along the contact of limestone and diorite. The deposit is irregular and varies up to 12 feet width. Developments consist of series of open cuts. Idle.

Bibl.: Rept. XV, p. 126.

Simonds Talc Mine. Darwin district, 17 miles by road southwest of Keeler. Elevation 5850 feet. The deposit occurs in a crushed zone in impure limestone, close to or in contact with an igneous intrusion. Strike of deposit N. 30° to 45° W., dip 60° to vertical. Outcrop can be traced for 3000 feet. The color varies from gray to pure white, and is hard and slippery. It is foliated and shattered, as is the inclosing limestone beds. The deposit is developed by a number of tunnels and open cuts. The main working tunnel is driven southeast 260 feet through limestone. From tunnel a series of raises into ore body, which shows a thickness of 70 feet on this level. Raise from this level connects with main glory hole near crest of hill. To east of these workings along the crushed zone, a number of lenses of talc of good quality have been developed which show widths of 20 to 60 feet. Talc mined from glory hole and stopes above tunnel level is trammed to ore bins. Hauled by trucks and teams from mine to grinding plant at Keeler.

Grinding plant. Crude talc passes through Jaw crusher to pass 1″ ring, then ground in Raymond mill to pass 200-mesh screen. Capacity 30 tons per day.

Shipping 1000 tons of ground talc per month, for manufacture of talcum powder, soaps, and to paper mills. From blocky talc make insulators for Edison Electric Appliance Company. Seven men employed at mine, and 12 men in mill. Property was purchased from

the California Talc Company in 1918, and has been under steady operation to date. Owners, Inyo Talc Company; president, P. H. Booth; secretary, Franklin Booth; M. A. Best, superintendent; Equitable Bank Building, Los Angeles, California.

Bibl.: Rept. XV, pp. 126-127.

Tramway Talc Mine. Keeler district. It is situated 3½ miles northwest of Keeler, at the base of the Inyo Mountains, near the mill of the Saline Valley Salt Company. Elevation 3800 feet. Bed of talc, greenish gray to black, exposed for thickness of about 8 feet in limestone. Idle. James Henry, George Brown, Lone Pine, California, owners.

Bibl.: Rept. XV, pp. 127-128.

TUNGSTEN.

There has been no activity in the mining of tungsten ores in Inyo County during the past two years due to low market and prices for tungsten concentrates. The known deposits are as follows:

In Tungsten Hills west of Bishop, Round Valley, Pine Creek deposits on south slope of Mount Morgan in the Sierra Nevada Range of mountains; Deep Springs Valley deposits and the Ubehebe district. The ores occur as scheelite.

MINES.

Deep Springs Valley Deposits. These deposits are situated 22 miles northeast of Zurich, a station on Southern Pacific Railroad, on the east slope of the White Mountains at the north edge of Deep Springs Valley. Eleven claims were located February, 1918, by D. F. Shively of Pig Pine. Series of parallel quartz veins containing scheelite, varying in width from mere seams to 4 feet. The veins are well defined quartz fissures in granite. General strike of these fissure veins is NE. and SW., dip about 25 degrees SE. On the Oversight claim a strong vein of quartz containing crystals of salmon colored scheelite up to 2″ in diameter, outcrops can be traced for full length of claim. The different veins have been exposed by open cuts and trenches, and judging from extent of croppings a large tonnage of milling ore can be developed. Idle. Owners, D. F. Shively and W. A. Sanger of Big Pine.

Pine Creek Tungsten Mine. Situated 45 miles by road northwest of Laws, on south slope of Mount Morgan, in Sierra Nevada Range. Elevation 11,200 feet. Holdings consist of five claims. Located in January, 1918. Contact metamorphic deposit, between dolomite footwall and granite hanging. Ore occurs as scheelite in minute crystals disseminated in a garnetiferous gangue. Ore carries from 0.6% to 1.28% WO_3.

Deposit strikes N. 50° E. and is 100 to 150 feet wide, and proven to have a length of 250 feet. The general trend of the formation is N. 40° W., but at the mine it is faulted and broken over, so that the strike is at right angles. The ore body is very similar to those at Bishop, scheelite in minute crystals being disseminated through gangue of

epidote, quartz, calcite and garnet. Adit tunnel driven 250 feet at 700 feet depth below outcrop. Ore mined by means of glory hole. Ore from bins at tunnel transported to mill over gravity tram 2200 feet in length.

Mill, 250-ton concentrating plant; 10″ x 20″ Blake crusher, two 5′ x 4′ Ball mills; two Colorado impact screens, 4′ x 4′ dewatering cone; 9′ diameter settling cone; 1 Overstrom slime table, 2 Overstrom Universal sand tables, 2 Overstrom finishing tables. Average mill heads run 1% WO_3; tails 0.13%. Extraction 70 to 75% producing a concentrate assaying 65% WO_3. Mill was put in operation the latter part of 1918 and operated until April, 1919, when forced to suspend operations on account of low market prices of ore. Pine Creek Tungsten Company; president, E. Cooper Shapley; secretary, H. M. Pancost, Philadelphia, Pennsylvania.

Round Valley Tungsten Mine. Situated 11 miles northwest of Bishop, on north slope of Tungsten Hills, at the edge of Round Valley. Elevation 5350 feet. Located as Noble mine in 1916, purchased by the

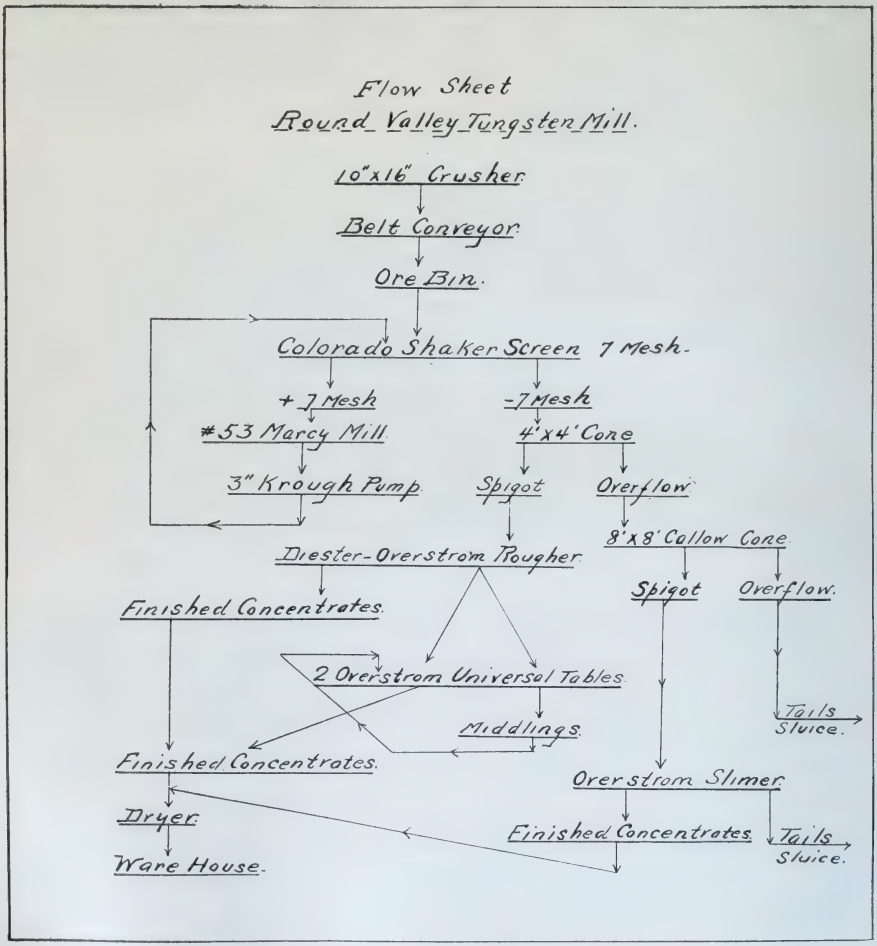


Plate IV. Flow Sheet, Round Valley Tungsten Mill.

company in 1917, started milling operations August, 1917. Contact metamorphic deposit. Ore body has white granite hanging wall and a footwall of marbleized or metamorphic limestone. The distance between two walls varies from 75 to 250 feet and the course of the ore body follows very closely the general trend of these walls. Scheelite occurs in a roughly banded rock composed chiefly of dark mica, epidote, quartz, and apatite. In the ore bearing formations are found parallel bodies of ore separated by stratas of metamorphosed limestone and lime silicate rock. Main ore body is 90 feet long and ranges in thickness from 25 to 35 feet and averages 1% WO_3.

Mine developed through 2 main adits, 50 feet apart vertically. Lower adit is 250 feet below uppermost croppings and is the main haulage way through which all ore is trammed to mill. Ore body trends NE. and SW., and stands at an angle of 45 degrees following the stratification of the enclosing rocks. Mining is carried on by the shrinkage system in the stopes and the glory hole method on the surface.

Mill, 100 ton capacity concentration plant equipped with 10″ x 16″ Climax rock crusher; No. 53 Marcy ball mill; Colorado shaker screen; (7 mesh) discharge from mill elevated by sand pump back over screen, then to 4′ x 4′ cone, overflow to 8′ x 8′ callow cone. Overflow from callow to tailings launder. Discharge to Overstrom slime table. Spigot discharge from shall cone to Deister-Overstrom rougher, concentrate cut, tails being treated on two Overstrom-Universal tables for final concentrate. Average mill heads ran 0.6%, tails 0.1% WO_3. Extraction 65 to 70%-60% WO_3 concentrate produced. See flow sheet. Idle.

Owner, Round Valley Tungsten Company; president, E. Cooper Shapley; secretary, H. M. Pancost, Philadelphia.

Bibl.: Adolph Knopf, U. S. G. S., Bull. 640*b*.

Standard Tungsten Company. This property, formerly known as **Aeroplane Group,** is situated 8 miles west of Bishop in Tungsten Hills. Elevation 5500 feet. Contact metamorphic deposit between granitic rocks and highly altered sediment. Main deposit on Aeroplane claim, about 600 feet above mill. Strikes north and south, dips vertically. Main adit tunnel driven S. 40° E. 270 feet to ore. Ore mined through glory hole is dropped through grizzly into chute on main tunnel, from where it is trammed to incline. About 3000 feet west of Aeroplane workings is Brockman claim. Here tunnel has been driven 108 feet to cut an ore body striking east and west, width 8′ to 10 feet. Ore from Brockman and Greenhole claims trammed 2000 feet to mill. Reduction equipment, 100 ton concentration mill, equipped with one 10″ x 20″ Jaw crusher, 1 Marcy ball mill, 5 mesh impact screen, 3 Diester baffle classifiers, 6 Overstrom tables; 1 Wilfley table. Ore treated varied from 0.4% to 0.6% WO_3. 60% extraction. Idle.

Owner, Standard Tungsten Company; president, A. B. Clark; secretary and manager, L. E. Porter, H. W. Hellman building, Los Angeles, California.

Bibl.: Adolph Knopf, U. S. G. S., Bull. 640b. Rept. XV, pp. 129-130.

Tungsten Mines Company. Formerly known as **Little Sister** and **Jack Rabbit** group of mines, situated 8 miles west of Bishop in Tungsten hill. Discovery made April, 1916, started mining May, 1916, mill erected during the summer, and milling operations started the first of

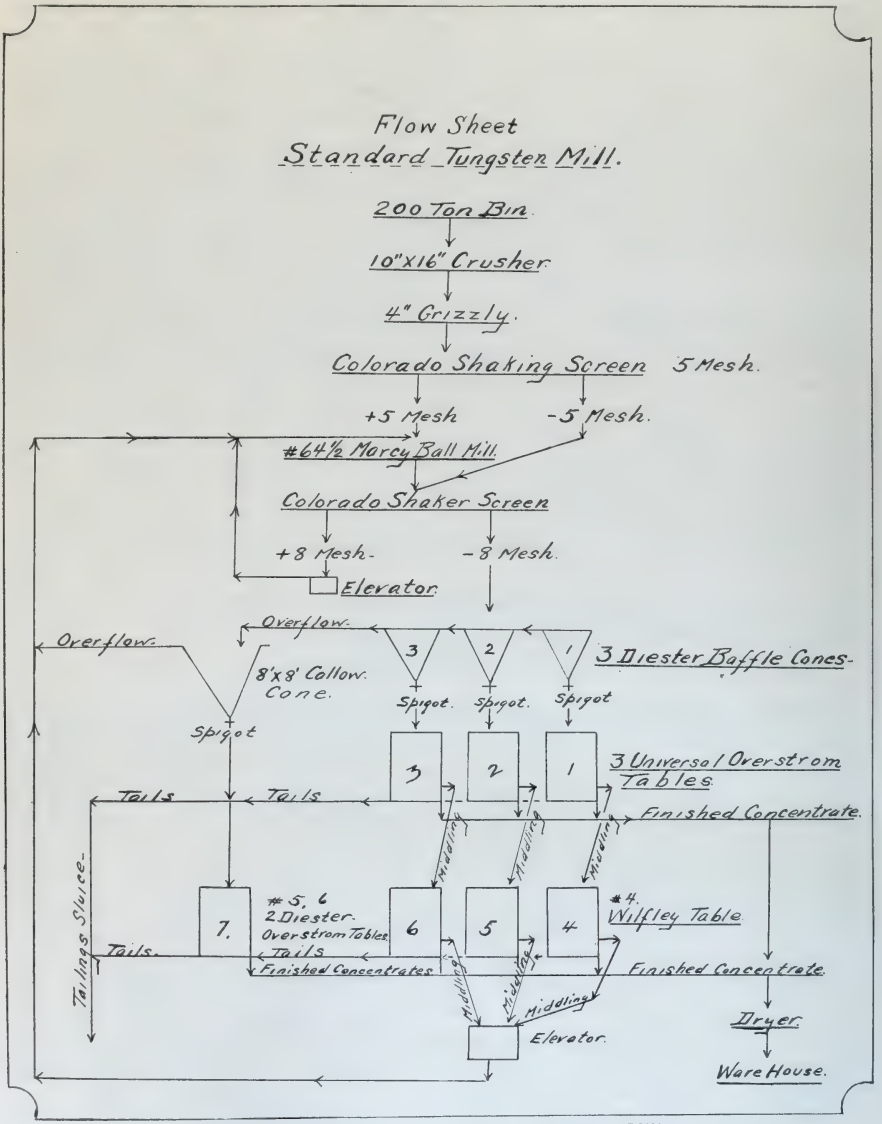


Plate V. Flow Sheet, Standard Tungsten Mill.

January, 1917. Holdings consist of 14 claims. Formation is granite. Contact metamorphic deposit, the ore consisting of scheelite associated mainly with garnet, epidote, and quartz. The main ore body, Little Sister claim, is near east margin of a large mass of metamorphosed sedimentary rocks embedded in quartz-diorite. These rocks consist of

limestone, quartzite, siliceous conglomerate, and metamorphic shales. Ore is said to average from 0.4 to 0.6% WO_3. Deposit strikes N. 40° W. and is 80 to 90 feet wide and about 280 feet in length.

Mine worked through adit tunnel 300 feet in length, which cut ore body 200′ vertically below outcrop. This adit is connected with glory hole by raise 35 feet above level. Glory hole is about 200 feet long, 80 feet wide and 165 feet deep. The ore body on NW. end is cut off by granite, and on SE. end by fault striking S. 80° W. Ore mined in glory hole goes through raise to two grizzlies, then dropped through to chutes on adit tunnel, and trammed to mill.

Mine equipment, (17″ x 10″) (14″ x 10″) Ingersoll Rand compressor operated by 20-h.p. motor.

Photo No. 37. View of Tungsten City and Mill of Tungsten Mines Company.

Concentration mill, capacity 250 tons daily. No. 5 Gates Gyratory crusher, 15″ x 40″ Allis Chalmers rolls, to 2-mesh Colorado impact screen, then to 15″ x 40″ rolls. Elevated to three 5-mesh impact screens, through size to 4 Isbel tables, oversize to 15″ x 30″ rolls; then to finishing tables, classifiers, etc. See flow sheet.

Mill made a recovery of 70%. Average product produced carried 63% WO_3. Ore reported to carry 3% to 6% WO_3. Idle.

Owners, Tunsten Mines Company; president, F. M. Townsend; secretary, F. W. Griffin; office, 301 Holbrook Building, San Francisco, California.

Bibl.: Adolph Knopf, U. S. G. S. Bull. 640b. Rept. XV, p. 133.

KERN COUNTY.

INTRODUCTION.

Kern County, because of its immensely productive oil fields, is the leading mineral producing county of California. The mineral production for 1919 being $67,153,361.00. This is larger by nearly forty million dollars than the succeeding county on the list. This figure also is approximately four times the value of the total gold output of the entire state for 1919. It is the third largest county in the state and is bounded on the north by Tulare, Kings and Inyo, on the south by Los Angeles and Ventura, on the east by San Bernardino, and on the west by San Luis Obispo. Outside of oil and gas development, mining is very inactive throughout the county. This being especially true of gold mining, which in the past has been the leading industry in the county, but on account of the increase in production costs, most of the producing mines suspended operations in the latter part of 1918.

Among the mineral resources developed and undeveloped of this section are: antimony, asphalt, borax, clay, copper, fullers earth, gems, gold, gypsum, iron, lead, limestone, magnesite, marble, mineral paint, natural gas, petroleum, potash, salt, soapstone, soda, sulphur and tungsten.

A brief outline will be made of the above minerals according to the activity displayed in mining the same, and only those that are being developed or have not been reported upon in previous reports will be discussed in this report.

ANTIMONY.

Antimony is found on a spur of the mountain bordering San Emigdio Cañon, in sections 10 and 15, T. 9 N,, R. 21 W., S. B. M., also on Erskine Creek, 4 miles south of Hot Springs, in section 23, T. 27 S., R. 33 E., M. D. M., 10 miles west of Koehn in sections 5 and 6, T. 30 S., R. 36 E., M. D. M. and 7 miles east of Bodfish, T. 27 S., R. 34 E., M. D. M. There has been no activity in the mining of antimony for sometime past, therefore for detailed descriptions of different mines and occurrences in the county, see Reports VIII, p. 680; X, pp. 225, 237; XIV, pp. 475-476.

ASBESTOS.

A serpentine belt cutting Jawbone Cañon carries asbestos in the form of chrysolite, the most noteworthy occurrence being in section 7, T. 30 S., R. 36 E., M. D. M., about 23 miles north of Mojave. However, there have been no deposits of commercial value found in the county.

Bibl.: Rept. XIV, p. 476.

ASPHALT.

Deposits of natural asphalt are found in the Buena Vista and Sunset Oil districts.

Bibl.: Rept. XII, pp. 26-28; Bull. 3, pp. 41-53.

BORAX AND POTASH.

The Mojave Desert contains a large number of dry lakes and sinks, which are the source of many salines, especially borax, potash, soda, and salt.

Bibl.: Bull. 24, p. 50. The Saline Deposits of California, issued by State Mining Bureau.

BRICK AND CLAY.

The clay deposits in the vicinity of Bakersfield, the county seat of Kern County, furnish excellent material for manufacture of brick.

An unusually good grade of pottery clay has been obtained from a large deposit in section 11, T. 9 N., R. 13 W., S. B. M., about 5 miles northwest of Rosamond.

The following companies are operating brick plants: Bakersfield Sandstone Brick Company, Bakersfield, California. Kern County Brick Company, Bakersfield, California.

Bibl.: Rept. XIV, pp. 477-478. State Mining Bureau Preliminary Report No. 7, p. 48; "Clay Industry in California," Bull. No. 38, p. 212.

CEMENT.

Los Angeles Aqueduct Cement Plant. Situated at Monolith, a station on Southern Pacific Railroad, and 3 miles east of the town of Tehachapi. Holdings consist of 120 acres, located in section 14, T. 32 S., R. 33 E., M. D. M. The limestone deposit is located north of the plant. There are also clay deposits on ground near the plant.

The plant has not been operated since the completion of the Los Angeles Aqueduct. The capacity of plant when operating was 1250 tons, and was operated by electric power furnished by the Pacific Light and Power Corporation. The plant has been recently leased by the city to the United States Potash Company of Los Angeles, California, primarily for the manufacture of potash, but it is also stated that the company will manufacture cement.

COPPER.

The occurrence of copper ores in the county are few and widely separated; there are, however, valuable deposits of copper near Woody, north of Randsburg, in the Garlock District; on the northern end of the Mojave Desert; and on the southeastern slope of the Sierras, in sections 7, 18, 19 and 30, T. 28 S., R. 40 E., M. D. M. and in sections 12, 13, and 24, T. 28 S., R. 39 E. Due to the present market price of copper there is no activity in the mining or development of copper mines in the above mentioned districts. Only those properties that have been developed since Report XIV of the State Mineralogist was issued will be mentioned in this report; for detailed description of the copper mines of the county see Report XIV, pp. 479-480, and Bull. No. 50, p. 297.

Greenback Copper Mine. It is the largest copper mine in Kern County; is located in sections 1, 2, 3, 4 and 10, T. 26 S., R. 29 E., in the town of Woody, 32 miles northeast of Bakersfield. Holdings of 500

acres. Was located in 1890 by present owner, and operated from 1916 until August, 1917. Six parallel veins occur in granodiorite, and are about 600 feet apart; average width 30 feet; strike northeast and southwest, dip 60 degrees north. Oxide zone extends to a depth of 60 feet, where sulphide zone was encountered. Ore consisting of chalcopyrite, chalcocite associated with iron pyrite occurs disseminated throughout the granodiorite. Ore stated to average 2% copper. Workings consist of an incline shaft 200 feet deep, and a vertical shaft 240 feet deep, with levels at 100′, 140′, and 200′. 1200 feet of drifting has been done on the 200 foot level. A winze 200 feet deep has been sunk on main ore body from the 200′ level on an incline of 45 degrees. Mine equipment consists of 30-h.p. Western gas engine hoist, 85 h.p. Western gas engine drives Ingersoll-Rand compressor. Mill flow sheet 100-ton concentration mill. Ore mined crushed to 1½″ product by 12″ x 20″ Wheeling jaw crusher. The crushed ore is discharged on 12″ belt conveyor which carries it up a 12° incline to mill bin. Then fed by Challenge feeder 6″ x 22″ Hardinge ball mill, from ball mill the product goes to Dorr duplex classifier which operates in close circuit with the ball mill, the oversize being returned to the feed box of the ball mill by a screw conveyor while fines go direct to 2-K. and K. flotation machines. The concentrates are collected in a wide launder with a steep slope, and elevated by means of a Krogh pump into Dorr thickener. A 5′ x 4′ Oliver filter is used to dewater the concentrates. The mill made a recovery of 75 per cent. It is stated that 100,000 tons of 2% copper ore has been developed in the mine. Idle.

Owner, Weringer Mines Company; I Weringer, president, Woody, California.

Bibl.: Bull. 50, p. 297; Rept. XIV, pp. 479-480.

Layman Group of Copper Mines. These mines are situated in the Goler Mining district, 6 miles northwest of Garlock, a station on the Southern Pacific Railroad. Holdings consist of 34 claims. A series of quartz veins cut the schist, which carry chalcopyrite associated with iron pyrite, the ore bodies form in lenses in the schist. Veins strike north and south, dip 45 to 60 degrees east. Width 3 to 6 feet. Development consists of an incline shaft 104 feet deep, sunk on an angle of 60 degrees, besides there are a number of prospect shafts and short tunnels. The ore is reported to carry from 3 to 6% copper with values in gold and silver. Owner, James M. Layman of Los Angeles, California; W. J. Walsh of Randsburg, California, agent.

Walsh and McClaude Group of Claims. Situated in the Goler district adjoining the Layman Group, 5 miles northwest of Garlock. Elevation, 3600 feet. Ore occurs as lenses in a mineralized schist carrying chalcopyrite with iron pyrite. There being a series of parallel quartzite veins in schist. Strike NW. and SE., dip 60° E. Width 3 to 6 feet. Developments consist of a number of prospect shafts and short tunnels. Idle. Owner, W. J. Walsh, J. McClaude of Garlock, California.

Walsh Group of Claims. Situated in the Goler mining district, 8 miles northwest of Garlock. Holdings 20 claims. Ore occurs along a series of NW. and SE. quartzite croppings in schist, on the north side of Sweet Home Cañon. Ore is chalcopyrite associated with iron pyrite

in a mineralized schist. Developments: Series of shafts 50 to 100 feet deep and tunnel 100 feet in length. Ore said to carry 6% copper with values in gold and silver. Idle. Owner, W. J. Walsh of Randsburg, California.

FULLERS EARTH.

California Fullers Earth Company. Mrs. H. L. Packard and Son, Bakersfield, owners, control 140 acres in section 14, T. 27 S., R. 28 E., about 18 miles north of Bakersfield. The deposit covers many acres and varies in thickness from 15 to 50 feet. Some material was shipped in 1919.

Bibl.: Bull. 38, p. 275; Report XIV, pp. 480-481.

The Eight Oil Company, with a small grinding plant at Bakersfield, were shippers in 1919 and 1920.

GOLD.

During years 1919 and 1920 there practically was no activity in mining gold ores in the county, most of the mines throughout the county suspending operations the latter part of 1918, on account of increased cost of production. The principal gold mining districts of Kern County are: Amalie, Clear, Creek, Cove, Green Horn, Green Mountain, Keys, Long Tom, Mojave, Pioneer, Rand, Tehachapi, Woody and Valley View. The only district that is active being the Randsburg district, where a few of the mines are operating that produce some high grade ore.

The following properties operating on a small scale in the county are:

Amalie Mine. It is located in section 22, T. 30 S., R. 33 E., M. D. M., about 18 miles northeast of Caliente, in the Amalie mining district. Recently purchased by the Hamilton Mining and Smelting Company of New York. Active development campaign planned on the property. A. J. Chapman of Caliente, manager.

Bibl.: Repts. XII, p. 141; XIII, p. 605.

Black Hawk Mine, 2½ miles south of Johannesburg, in Rand mining district, D. E. Blue of Randsburg, owner.

Bibl.: Rept. XIV, p. 489.

Blue Mountain Mine. Woody district. Owned by Blue Mountain Mining Company, J. W. Howard, president; Rodney McCormick, secretary, Bakersfield, California.

True fissure vein in granodiorite. Width 12″ to 2′. Developments, shaft 500 feet with drifts on 100′, 200′, 300′, 400′ levels. It is reported that 20,000 tons of ore have been developed. Company planning to install a mill. Twelve men employed.

Consolidated Mines Company (Good Hope Mine), 413 H. W. Hellman Building, Los Angeles. Mines are situated at Randsburg, in Rand mining district.

Bibl.: Rept. XIV, p. 496.

Keyes Mine. It is situated in section 26, T. 26 S., R 32 E., M. D. M., in Keyes district, about 3 miles southeast of Isabella, at an elevation of 3600 feet. Tunnel has been extended 1200 feet. Five-stamp mill operated part of the time, when they have a tonnage of high grade ore developed. Operated by the Keyes Mining and Milling Company of San Diego, California. A. M. Arnold, superintendent.

Bibl.: Repts. XII, p. 145; XIII, p. 191; XIV, p. 499. U. S. G. S. Mineral Resources of U. S.

Tropico Mining and Milling Company (formerly known as **Big Three Mining Company),** 448 Wilcox Building, Los Angeles; O. S. Richardson, president; S. E. Brown, secretary; E. A. Cochran, manager. Owns a group of mines in the Mojave Mining District, 4 miles east of Rosamond, a station on the Southern Pacific Railroad. Elevation 2300 feet. Holdings consist of sixteen claims. Four parallel veins occur in quartz-porphyry. Strike northeast and southwest, dip 68° south. Width of veins varies from 3 feet to 80 feet. Ore shoots developed on these veins run from a few feet up to 250 feet long, with an average width of 3 feet. Workings consist of shaft 540 feet deep, with levels at 100′, 200′, 300′, 400′ and 500′. There are 2350 feet of drifts on main vein, on No. 1 vein 350′, No. 2, 160′, and Lida vein 450′. Crosscuts total 3200 feet.

Equipment, 45-h.p. electric motor hoist; 320 cu. ft. compressor; 10-stamp mill and cyanide plant. Mine and mill were operated until February 1, 1920. Twenty-five men were employed. H. C. Burton, superintendent.

Shipsey Mine. (King Solomon Consolidated Mines). Situated ¾ mile west of Johannesburg, in Rand district. Operated by leasers. Five-stamp mill. Three men employed. Owner, Shipsey Mining Company, 530 South Spring street, Los Angeles, California.

Yellow Aster Mine, the largest gold producer in southern California, and one of the noted mines of the state, suspended operations on February 1, 1920, on account of increased cost of production. The mine is situated at Randsburg, in the Rand mining district. Yellow Aster Mining Company of Los Angeles, California, owner.

Bibl.: Rept. XIV, p. 514.

GYPSUM.

Gypsum deposits of varying quality occur for many miles along the lower foothills of the Sierra Nevada, reaching from Caliente on the south nearly to Porterville on the north.

In the valley of Cottonwood Creek 5 miles north of Pampa station, on the Southern Pacific Railroad, the beds are rather extensive and a number of mines have been opened. The gypsum occurs both as a crust on the surface and as interstratified beds.

Gypsite deposits occur in about 6 miles southeast of Dudley, Kings County, in the Sunflower Valley, Kern County, in township 25 S., R. 18 E.

Deposits of gypsite are found in the Lost Hills in the San Joaquin Valley, a few miles south of Tulare Lake and about 25 miles west of Wasco, a station on the Santa Fe Railroad, the most extensive occurrence being in section 30, T. 26 S., R. 21 E. The beds in this locality are very extensive, being about 2 feet in thickness, and are said to extend 6 to 7 miles along the hills. The deposits occur in Tertiary sandstones and shales. Deposits of gypsite are found in many places in the neighborhood of McKittrick in the Tertiary sandstones and shales, located in sections 21 and 30, T. 30 S., R. 22 E. In what was the bed of Kern Lake, but is now a part of a large ranch belonging to the Kern County Land Company, gypsite has been exposed in sections 26 and 27, T. 32 S., R. 27 E. The deposit is about 20 miles southwest of Bakersfield, but only 5 miles from the railroad station known as Conner.

Gypsite is also reported from a point one-half mile farther south. The gypsite on the above mentioned ranch is reported to be 4 feet thick.

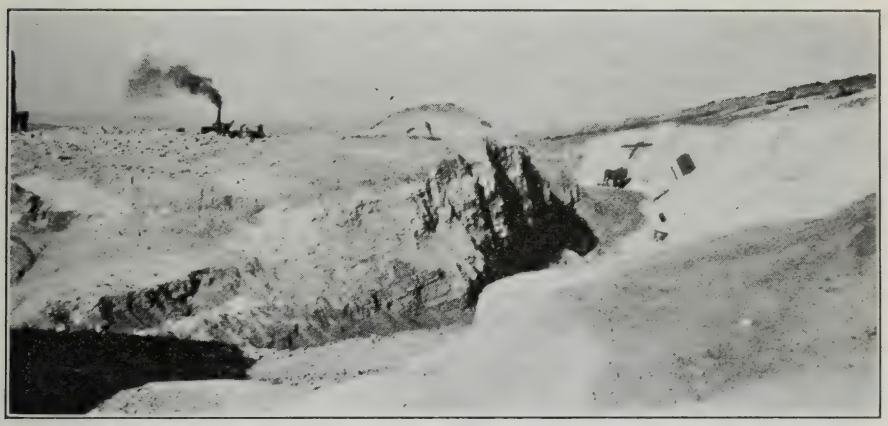


Photo No. 38. Open Cut, Bissell Magnesite Mine, Bissell, Kern County.

Gypsum deposits also occur near Cave Springs about 25 miles northeast of Mojave and 3½ miles southeast of Cave Springs and Cantil, on the line of the Southern Pacific Railroad, joining Mojave and Randsburg. Gypsite is exposed at the surface over an area covering nearly one square mile. The thickest beds lie in section 28, T. 30 S., R. 38 E., and reach a depth of 10 feet. In the country closely adjacent to Maricopa, known as the Sunset district, are a number of small areas carrying thin deposits of gypsite associated with shales.

Bibl.: Repts. X, p. 223; XI, p. 233; XII, p. 324. U. S. G. S. Bull. 223, p. 121; Bull. 413, pp. 16-20; Bull. 430, pp. 145-146; Bull. 697, pp. 64-73.

W. A. Fauntleroy owns a deposit in sections 21, 27, 28, 29, T. 29 S., R. 30 E., M. D. M., on both sides of Cottonwood Creek.

California Gypsum and Mineral Company. The property of the California Gypsum and Mineral Company is located on the north slope of a rather low hill in the S. ½ of section 20, T. 30 S., R. 22 E., about ½ mile from McKittrick railway station.

The gypsite is overlain by 6 inches to 2½ feet of soil and is a buff color. It has been mined in a number of places at a depth of 2 feet. Several hundred tons of gypsite for use as land plaster has been shipped from the deposit, and there is a small plant on the property for the preparation of the material.

Ebbott and Hickox own a deposit in section 30, T. 30 S., R 32 E., about 2½ miles southwest of McKittrick. The deposit that has been worked is about 500 feet long, 200 feet wide. The gypsite is from 2 to 4 feet thick and is overlain by soil 2 feet thick in places. About 4000 to 5000 tons have been shipped.

IRON.

Deposits of iron ore occur at Woody in sections 10 and 15, T. 26 S., R. 29 E., M. D. M. At foot of Mount Breckinridge in section 4, T. 29 S., and near San Emidio in section 17, T. 9 N., and R. 21 W., S. B. M. These deposits are small, and their commercial value is doubtful on account of high cost of transportation.

Bibl.: Rept. XIV, p. 516.

LIME AND LIMESTONE.

The lime industry is a large and important one at Tehachapi on the Southern Pacific and Santa Fe railroads.

Extensive deposits of crystalline limestone occur at many points in this area, also at Keene, and along Erskine Creek, some 30 miles north of Caliente.

The deposits of the Jameson Lime Company, situated in the west half of section 14, T. 32 S., R. 33 E., M. D. M., about 2 miles east of Tehachapi have recently been taken over by the Blue Diamond Plaster Company, 2200 East Sixteenth street, Los Angeles, California; J. W. Jameson, president; W. C. Hay, vice president; B. E. Dequine, secretary; Howard Booker, manager. The plans of the company are to operate the property on a large scale.

Bibl.: Bull. No. 38, p. 70; Rept. XIV, pp. 516-518.

Summit Lime Company, owns 640 acres, patented in section 35, T. 12 N., R. 15 W., S. B. M., about 3 miles south of Tehachapi. F. O. Wyman, president; A. M. North, secretary; offices, 708-709 Marsh-Strong Building, Los Angeles, California. The company is operating the quarry and lime kilns to capacity. Present capacity of plant being 560 barrels per day. About 40 to 50 men are employed.

Bibl.: Rept. XIII, p. 628; Bull. 38, p. 71; Rept. XIV, p. 518.

MAGNESITE.

Bissell Magnesite Deposit. It is situated 1½ miles north of Bissell Station on the Santa Fe Railroad and 11 miles southeast of Mojave. Holdings consist of 40 acres on railroad land. Recently purchased by

International Magnesite Company, Dr. R. Shiffman, president, Chamber of Commerce Building, Pasadena, California.

It is said to be the only occurrence of magnesite of sedimentary origin that has been reported in the United States. The magnesite occurs in beds interstratified with clay, clay shales, the whole having a width of 300 feet and can be traced for a distance of 2500 feet. General strike of beds is east and west, dipping 29 degrees south. The magnesite stratas vary from mere seams up to 4 feet thick.

Developments consist of open cuts 2200 feet in length, two shafts, No. 1 and No. 2. No. 1 shaft is 100 feet deep with a drift 400 feet west and 200 feet east on the 100 foot level. Series of raises from this level cutting the different stratas. No. 2 shaft is 50 feet deep. Most of the magnesite mined has come from open cuts and was worked by means of a dragline scraper first removing the overburden and working the stratas separately. During 1917 shipped to the International Refractories Company at San Diego, California, from 300 to 500 tons of magnesite, stated to carry 80 to 85% Mg CO_3, 7% Si O_2 2 to 4% Ca CO_3. Idle.

Bibl.: U. S. G. S. Bull. 540, pp. 512, 516.

MARBLE.

Marble occurs near Neenach, on the south slope of the Tehachapi range in Brights Valley, in the San Emigdio Cañon and along Erskine Creek. The Neenach deposit is the only one that has been worked.

Bibl.: Repts. VI, Part I, p. 23; VIII, p. 629; XIV, p. 520; Bull. 38, p. 100.

MINERAL SPRINGS.

Kern County has a number of mineral springs, especially along Kern River.

Bibl.: U. S. G. S. Water Supply Paper No. 338; Rept. XIV, p. 520.

PETROLEUM AND NATURAL GAS.

Kern County produces more petroleum than any other county in California. Petroleum production of the county for 1919 amounted to 47,734,035 bbls., valued at $64,440,947.

The production of natural gas in 1919 amounted to 25,363,739 M. cu. ft., valued at $1,618,913. The principal oil and gas producing districts are as follows:

Kern River, McKittrick, Midway-Sunset, Lost Hills, Belridge, Coalinga, Elk Hills and Devils Den.

The notable gas development in 1919 in California was the bringing in of two large dry-gas producers by the Standard Oil Company in the Elk Hills in western Kern County. The largest natural gas field of commercial importance thus far developed in California is in the Midway district. The area of proved oil land in Kern County is about 58,371 acres, with 5324 producing wells, far greater than any other county in the state.

For detailed description of the different oil producing districts, see Bulletin 69, and "Summary of Operations of California Oil Fields," Sixth Annual Report of the State Oil and Gas Supervisor, issued by the California State Mining Bureau.

QUICKSILVER.

Quicksilver production in Kern County began in 1916, following the discovery of cinnabar in workable quantities close to the Tehachapi Loop of the Southern Pacific Railroad, near the town of Tehachapi.

Cuddeback Cinnabar Mine. J. P. Cuddeback, Tehachapi, owner; Cuddeback Cinnabar Company, lessee, Tehachapi; A. J. Blackley, president. The mine is on land owned under an agricultural patent, being in section 27, T. 31 S., R. 32 E., M. D. M., 3 miles from Woodford Station on the Southern Pacific, and a half mile by road from the main county road at the Loop.

The country rock for several miles around is granite, and the white rhyolite dike traversing the granite with a nearly EW. strike is plainly visible, though the outcrop is not a bold one. The dip is N., about 45°; and the width is about 60 feet. Cinnabar crystals are disseminated through this dike material. The richer accumulations of ore appear to be associated with certain cross-fissures in the dike which are marked by the presence of brown clay seams. The mineralized portion of the dike is about $\frac{1}{3}$ of a mile long. The development work consists of several short adits, drifts, small stopes and open cuts, and when visited a depth of about 50 feet below the outcrop had been obtained from the gulch. However, most of the work has been entirely confined to open cuts along the outcrop. Since property was visited a crosscut tunnel has been driven to cut the dike at a lower elevation below the glory hole. Reduction equipment consists of a 12-pipe Johnson-McKay retort, oil-fired. Idle.

Bibl.: Bull. 78, pp. 47-48; issued by State Mining Bureau.

Fickert-Durnal Mine. J. P. Cuddeback, Tehachapi, owner; Phillip Fickert, Bakersfield, and J. A. Durnal, Tehachapi, lessees. This prospect is on the Cuddeback Ranch property, being a mile southeast, in SW. $\frac{1}{4}$ of SW.$\frac{1}{4}$ of section 26, T. 31 S., R. 32 E., M. D. M., 4 miles from Woodford, and about 7 miles from Tehachapi. The ores occur in an altered igneous dike rock, traversing the granite with a NW.-SE. strike, and a dip NE. The cinnabar is in part disseminated and in part in seams in the altered dike material. There is a little associated pyrite. Developments consisted of 3 short adit drifts and a 25-foot shaft near bed of ravine. A 6-pipe Johnson-McKay retort on the property. Idle.

Bibl.: Bull. 87, "Quicksilver Resources of California," pp. 47-49.

SANDSTONE.

A large quantity of sandstone is found a few miles south of Tehachapi and in San Emigdio Cañon.

Bibl.: Bull. 38, pp. 128 and 370; Rept. XIV, p. 522.

SALT.

Consolidated Salt Company, 528 Los Angeles Investment Building, Los Angeles; J. R. Burns, president. This company is working a deposit of rock salt in an old lake bed at Saltdale, a station on the Southern Pacific Railroad, and 35 miles NE. of Mojave. The mill is located at Saltdale. Six to ten men are employed. Capacity of plant is about 200 tons monthly.

SILVER-LEAD.

Bee Hive Mine. It is situated 3 miles northwest of Rand, a station on the Southern Pacific Railroad, in the Goler mining district. Holdings consist of four claims. Vein occurs on contact of limestone and granite, with a width of 12″ to 18″, can be traced on surface for ½ mile. Developments consist of shaft about 100 feet deep. Ore extracted from vein in the shaft is reported to assay: Silver, 25 ozs., lead 20 to 50%. Three men employed. Owner, M. J. Lovett, of Randsburg, California.

TUNGSTEN.

Scheelite, the principal tungsten mineral of the state is found in the Amalie, Keys, Rand and Stringer districts where it is usually associated with gold bearing veins. There is no activity in the mining in these districts due to the low market price of tungsten ores. Since the fourteenth Report was issued a number of deposits were developed which will be described:

Bald Mountain Group of Tungsten Claims. These claims are situated on the northeast slope of Bald Mountain, in section 14, T. 27 S., R. 32 E., 5 miles southwest of Isabella. Elevation 3600 feet. Holdings consist of 12 claims. Scheelite occurs in two parallel quartz veins which strike NE. and SW. and have a slight dip to the SE. Scheelite crystals occur disseminated through the quartz associated with iron pyrite. The outcroppings of the veins can be traced for 3000 feet, showing a width of 6 feet. The two veins known as the Buckeye and Buena Vista are about 500 feet apart and cut a biotite granite. Developments consist of a number of adits and shallow open cuts. It is reported that the ore mined carried from 0.5% to 1% WO_3. Two tons of ore concentrated from the Buena Vista claim produced 380 lbs. of concentrates assaying 67% WO_3, while 6 tons from the Buckeye vein produced 240 lbs. of concentrates, 60% WO_3. Sulphur content being 0.18%. Idle. Owners, C. B. Ross, John Ross and Henry Ross, Bodfish, California.

Howe Group of Claims. Situated 3 miles northeast of Havilah, on southwest slope of Bald Mountain. Scheelite occurs in quartz veins in a biotite granite, associated with iron pyrite. Holdings consist of six claims. Owner, J. C. Howe of Havilah, California.

King Tungsten Mine. The mine is situated 2½ miles northeast of Havilah, on the southeast slope of Bald Mountain, and 25 miles northeast of Caliente. Elevation 3200 ft. Scheelite occurs in quartz veins in a biotite granite, associated with iron pyrite. There are two parallel veins, from 3 to 5 feet in width, and about 25 feet apart. Strike N.

40° W., dip 70° SE. Developments consist of a crosscut tunnel 115 feet to vein, with 75-foot raise to the surface, also a number of open cuts on the two veins.

Mill, twenty-five ton capacity, 8″ x 10″ Blake crusher, Ball mill, and two Eccelson concentrators. Ore milled is reported to have carried 1.14% WO_3. Idle. Owner, King Tungsten Mining Company, 627 National Bank Building, Los Angeles, California; Frank Potts, president; Albert Grem, secretary.

Ophir-Zuck Group of Tungsten Claims. A. D. Zuck of Havilah, California, owns a group of claims, 5 miles south of Havilah, situated on what is known as the Red Hills. Minute crystals of scheelite occur in a garnetiferous dike on contact of limestone and schist. The scheelite occurs associated with quartz, garnets, and epidote. In one of the quartz outcrops, some high grade crystals of scheelite were extracted. Crystals being from ½″ to 4″ in size. Idle. Owner, A. D. Zuck of Havilah, California.

Ratcliffe Mine. The mine is situated on main highway between Atolia and Randsburg, in the Rand mining district. Elevation 3700 feet. Scheelite occurs in a narrow vein in schist, striking east and west, with a general dip south. It lies east of a prominent diorite dike, striking N. and S., and which forms the division between the Stringer and Rand districts. Mine is opened by a 150-foot vertical shaft, with levels driven on the vein east and west at 65′, 100′, and 150′. The mill on the property has a capacity of 25 tons. Idle. Owner, J. H. Ratcliffe, Randsburg, California.

Royal Bohee Group of Mines. It is situated 7 miles east of Garlock Station, on Southern Pacific Railroad, on the west slope of Rand Mountains. Elevation 4000 feet. Scheelite occurs in stringers of quartz, varying in width from a knife blade up to 6″ in a green amphibolite schist. The zone in which the stringers occur is about ½ mile, running north and south. There are two systems of fissuring: Main system, striking N. 50° E. and a series of parallel fissures breaking off of the main fissures, striking due east and west. Main working consists of a tunnel driven 240 feet N. 75° E. on a cross fissure. Dip of ore body here is 65 degrees south. Width of stringer drifted on being 4″, and said to carry 4 to 6% WO_3. Several other tunnels and drifts have been made on other stringers. Idle. Owner, Al Powell of Randsburg, California.

Sunset Group of Mines. The group consists of nine claims situated 6 miles southeast of Garlock, a station on Southern Pacific Railroad, on a low isolated hill at west border of the Rand Mountains. Elevation 2800 feet. Deposit consists of narrow quartz stringers 2″ to 6″ wide in a belt of limestone carrying scheelite. The gangue is quartz and calcite. The deepest working is a shaft sunk 35 feet on a stringer. Other work consists of several small cuts and trenches. A strong vein of calcite, carrying scheelite occurs at contact of limestone and schist, striking N. and S. This vein is about 6″ wide and its outcrop can be traced for over a thousand feet. When mine was operating the ore was milled at the Ratcliffe mill. Owners, M. J. Lovett, W. M. Price and associates of Randsburg, California.

LOS ANGELES COUNTY.

There is only a small production of metals in Los Angeles county, its principal wealth being in structural and industrial materials, also petroleum and natural gas, which in 1919 amounted in value to $23,606,381. Its output of brick and tile was over a million dollars, and that of petroleum amounted to over twenty million dollars.

The great increase in population of the City of Los Angeles, and the expansion of the city, industrially and commercially, has brought into prominence the possibilities of its being the great manufacturing center of the Pacific Coast, with an assured market for manufactured products.

Among its mineral resources may be noted asphalt, barytes, borax, brick, clay, fuller's earth, gems, gold, gypsum, infusorial earth, limestone, marble, mineral paint, mineral water, natural gas, petroleum, salt, glass-sand, sandstone, serpentine, silver, soapstone, and miscellaneous stone.

This report will be confined entirely to mineral deposits that are under active operation or have not been described in previous reports of the State Mining Bureau.

BARITES.

San Dimas Cañon Barytes Deposit. It is situated 8 miles northwest of San Dimas, in section 23, T. 1 N., R. 9 W., in the west fork of San Dimas Cañon. A massive outcrop of baryte occurs on the west side of the cañon, having a width of 6 to 8 feet, and is about 50 feet in length. The general strike of the outcrop is NE. and SW. with slight dip to the southeast. On the ridge above this outcrop are also several small lenses of baryte. The baryte is white in color, and said to carry from 85% to 87% barium sulphate. Idle. Owners, W. G. Fields, H. E. Howard, C. Fairbanks of San Dimas, California.

BORAX.

The **Sterling Borax Company** of 320 Trust and Savings Building, Los Angeles; Thos. Thorkildson, president. Operated mine and mill to capacity during the past year. Fifty men are employed. The mine is 5 miles north of Lang in Tick Cañon.

CLAYS.

The brick clay deposits within the limits of Los Angeles and vicinity consist principally of loam (clay in which there is a considerable proportion of sand) which contains numerous inclusions of pebbles. In Chavez Cañon in the northern part of the city, a bank of clay shale is used. West of Los Angeles near Santa Monica is found the best clay for the manufacture of brick and tile. No high grade clays are produced in the county, those used being shipped in from Amador, Placer and Riverside Counties. For description of different brick and tile plants under operation see Preliminary Report No. 7, pp. 49-63, "Clay Industry in California;" Report XV, pp. 488-499.

COPPER.

There are no producing copper mines in Los Angeles county, but a number of interesting deposits of complex ores, carrying antimony, copper, nickel, cobalt, lead and zinc occur in Pacoima Cañon, which are worthy of mentioning.

Denver Mining and Milling Company, Prof. R. L. Fraisher, president, Cecile Peabody, San Fernando, California, secretary, own 28 claims, 12 miles northeast of San Fernando, in Pacoima Cañon, and about 9 miles from the entrance of the cañon. Elevation 2610 feet. The principal claims are known as: Denver, Chance, Fenner, Indicator and Red Ledge. There are a series of parallel quartz veins traversing a country rock of schist and gneiss, striking N. 80° E., dipping 60 to 80 degrees south. The veins vary in width from 2 to 4 feet, with the exception of the Red Ledge vein which in places is 20 to 50 feet wide. The ore is a complex sulphide, carrying massive pyrrhotite, chalcopyrite, galena, sphalerite, and stated to carry traces of nickel, cobalt and antimony. These sulphides occur in lenticular masses in the different quartz veins. Developments consist of a number of shallow shafts, and tunnels on the different veins. The principal claims that have been developed to any extent are: Denver, Chance, and Fenner. Three men are employed. W. S. McGrew of San Fernando, California, manager.

GRAPHITE.

American Graphite Company. Home office of company, Milliken Building, Decatur, Illinois; Dr. J. W. Sanders, president; Dr. Kuick Sanders, secretary. Local office, 211 Grant Building, Los Angeles, California; Albert Maltman, general manager. The company is developing a deposit of graphite in Kagel Cañon, 8 miles east of San Fernando, California. Holdings consist of five claims. The graphite occurs disseminated in very small flakes through an outcrop of schist 10 to 20 feet wide. Nearly all the graphite is in flakes 0.25 millimeter in diameter or less. The other minerals in the graphite schist are quartz feldspar and small quantities of pyrite. The ore is reported to carry from 7% to 15% graphite. The vein can be traced for a distance of 4000 feet, and outcrops through 3 full claims. The course of the vein is N. 30° W. and dips 70° east. A tunnel 60 feet long has been driven on the vein at an elevation of 2400 feet. About 200 feet south of tunnel at top of ridge an open cut on the outcrop exposes the vein for a width of 20 feet. About 4000 feet south of the tunnel there is a large open cut on the vein which exposure shows width of 20 to 30 feet. Six men are employed on construction of 50 ton concentration mill: Crusher, rolls, Marks pulverizer, tube mill, 2-Allingham flotation machines, and Oliver filter.

California Graphite Company, O. M. Souden, president; A. R. Plumb, secretary; Los Angeles office, 402 Bryson Building, Los Angeles, California.

This company has two groups of claims in sections 11 and 12, T. 6 N., R. 15 W., S. B. M., 18 miles NE. of Saugus, in a branch of San Fran-

cisquito Cañon. Graphite occurs disseminated in very small flakes through a schist which is very much decomposed on the surface. Nearly all the graphite is in flakes of 0.25 millimeter in diameter or less. This vein of graphite schist is 8 to 25 feet wide in a granitic country rock, striking north of east and dipping at a steep angle. The outcrop can be traced on the surface for the length of five full claims. The principal mineral of the graphite schist is the aluminum silicate sillimanite, other minerals are quartz, feldspar and small quantities of pyrite. Analysis by U. S. G. Survey of graphite schist ran from 7.29% to 17.48% graphite. A new vein has been developed on the property which in places shows a width of 50 feet. Workings consist of series of tunnels and open cuts. New concentration plant has been installed on the property having a capacity of 50 tons. The concentrates supply the local market for foundry facings, and also paint and lubricants. The property has been operating continuously during the past two years.

Bibl.: Rept. XV, pp. 501-504.

Verduga Mountain Graphite Deposit. It is situated 12 miles northeast of Los Angeles, and 2½ miles northwest of Montrose, in section 29, T. 2 N., R. 13 W. A stratum of graphite schist occurs in granite on the northeast slope of Verduga hills. It is exposed only in two places—the main exposure being in an open cut about 130 feet above the floor of the valley. The face of the cut exposes a deposit 20 to 30 feet wide and at least 30 feet high. The graphite is more or less weathered here, and mixed to a small extent with the decomposed country rock. The graphite appears to be crystalline, but in small flakes, and very little or no mica is associated with it, other gangue being principally quartz and feldspar. The strike of the vein appears to be to the southwest, and dips steeply to the southeast. About 80 feet higher up the mountain and along the strike of the deposit, a shallow pit 3 feet in diameter exposes the vein.

Developments: At an elevation of 1350′, a tunnel has been driven southwest a distance of 60 feet, and is 70 feet below the floor of the open cut. In the face of this tunnel a vein 5 feet wide was cut, which strikes southwest, and with a dip of 45 degrees southeast. Some ore was mined from the deposit during 1920, being milled in Los Angeles. The graphite is suitable for paint, lubricants, and foundry facings. Idle.

Owner, J. E. Hostetter, 917 Washington Building, Los Angeles, California.

Bibl.: Rept. XV, p. 504.

INFUSORIAL OR DIATOMACEOUS EARTH.

Deposits of this important material occur in Los Angeles county, but there has been no commercial production. However a deposit is being developed near Covina, on the Chaffey ranch, in the hills south of the Masonic Home, by D. F. Meikeljohn and Robert Burhans, Jr. of Pasadena. Ten men are employed, opening up a quarry face.

MANGANESE.

Amargosa Group of Claims. The deposit is situated 5 miles by road west of Palmdale, in township 6 N., Rs. 12 and 13 W., S. B. M. Holdings consist of 9 claims. Irregular kidneys of manganese occur along siliceous outcrops in schist.

The most extensive outcroppings are 1 mile north of the Palmdale road. Here the manganese outcrops along an east and west strike, at intervals for about 150 feet. Varies in width from 2 to 5 feet. The silica content is high.

Developments consist of a number of open cuts, tunnels and shallow shafts. During 1917 the Llewellyn Iron Company operated the property. Idle.

Owner, Llewellyn Iron Company of Los Angeles, California.

PETROLEUM AND NATURAL GAS.

The production of petroleum in Los Angeles County increased approximately 5,000,000 bbls., or 50%, in 1919. The increase was largely due to the Montebello field. The county ranks third in the state as a mineral producer in 1919, passing Fresno County, which was fourth in 1918. The advance being due to the large increase in the petroleum output and valuation. Petroleum produced was 15,076,633 bbls., valued at $20,805,754.

The production of natural gas was 4,148,476 M. cu. ft., valued at $458,812. For detailed description of the different oil fields see Bulletin No. 69, "Petroleum Industry of California," also Annual Reports of the State Oil and Gas Supervisor, issued by the State Mining Bureau.

SILICA.

Silica occurs quite abundantly in this county, and has been worked to a moderate extent in the past. Large quartz veins of high purity are frequent, but at present none of the deposits is being worked. Most of the silica for use in the glass factories comes from Amador, Riverside, and San Diego counties.

Hermosa Beach Glass Company manufactures window and automobile windshield glass. Office of the plant is at Hermosa Beach. Adolph Wuchner, president and manager. The plant has a daily capacity of 600 boxes of window glass. Limestone is secured from Riverside County, and silica sand comes from San Diego County.

Torrance Window Glass Company, manufacturers of window glass, Torrance, California. Office of plant, Torrance. Julius Conrad, president. Charles L. Bisbee, secretary. The original plant was destroyed by fire on July 27, 1919, but the new plant has been built and is operating to capacity. The capacity of present plant is 12,000 boxes of glass per month. Silica sand comes from La Jolla, San Diego County, sulphate of soda from San Luis Obispo County, lime from near Crestone, Riverside County. Three hundred twenty-five men are employed at the plant. E. P. King, manager.

SOAPSTONE AND TALC.

Deposits of soapstone and talc occur on the ridges on both sides of Boquet Cañon, 13 miles west of Palmdale and 16 miles northeast of Saugus.

Boquet Canyon Talc Mine. The deposit is situated 13 miles west of Palmdale, on a steep hillside about 1000 feet above the floor of the valley. Six claims have been located. A body of greenish colored talc occurs at contact of chloritic schist and serpentine. The extent of the deposit is unknown, owing to overburden. Outcrop on the surface on one of the claims for 200 feet, shows a width of 14 feet. General strike is NW. and SE. The talc is much broken at the surface, but appears to be more solid in depth. Developments consist of a tunnel 70 feet in length, giving a depth of 75 feet below outcrop. The talc is suitable for making crayons for metal workers, also for use in tires, but does not grind white, therefore not high grade enough material for talcum powder. H. F. Nelles, 1308 Huntington drive, South Pasadena, California, owner.

Commack Talc Deposit. The deposit is situated on the north side of Boquet Cañon, 16 miles northeast of Saugus. Six claims have been located. Elevation 2500 feet. Body of greenish talc 7 to 10 feet wide, on contact between chloritic schist and quartzite. Formation strikes NE. and SW. Dip 60 degrees NW. A number of open cuts made on this belt of talc show some fair grade material, but it is much shattered, and so far no solid masses have been developed. Owner, J. R. Commack, 1943 Wilcox avenue, Hollywood, California.

Soda Products Company. This company owns a deposit of talc, 13½ miles northeast of Saugus on steep hillside about 1000 feet above the floor of the valley, on southeast side of Boquet Cañon. Body of greenish colored talc at contact of chloritic schist and serpentine. The talc is much broken on surface, but appears more solid in depth. Several open cuts have been made along the outcrops, which expose talc of good quality. The talc is suitable for making crayons for metal workers, and is said to conform to U. S. specifications as to strength tests.

Owners, J. L. Clark, E. S. Gates and associates, 1724 Highland avenue, Los Angeles, California.

Debney Talc Mine. It adjoins the Commack mine and is 16 miles northeast of Saugus, on slope of ridge northwest of Boquet Cañon. Body of greenish talc 25 to 50 feet wide in chloritic schist. Strike NE. and SW. Dip 60° to NW. Open cut on the talc body, exposing some fair grade material. Some material was hauled from this deposit and shipped to Los Angeles. Owner, C. G. Dabney, 1749 North Cahuenga, Hollywood, California.

STONE INDUSTRY.

The extended and ever increasing use of concrete for building and pavements makes the supply of crushed stone a matter of importance.

The stone chiefly crushed in this county for concrete is granite, of which boulders and cobblestones in immense numbers are distributed widely over the river washes which form where the mountain streams

emerge from their rocky cañons, bearing along in their torrential flow great quantities of fragments from the cañon walls. Five crushing plants are operated on the Pacoima, Tejunga, Arroyo Seco, and San Gabriel washes by the Union Rock Company, 2644 Compton avenue, Los Angeles, California; H. L. Hodges, president; A. C. Stone, secretary.

The Union Rock Company has taken over the Los Angeles Stone Company's quarry and plant, located on the east slope of Brush Cañon, near Hollywood, California. Capacity 500 tons per day. Twenty men employed.

Also the Los Angeles Stone Company's plant near Roscoe station, in township 5 N., R. 14 W. Output of sand and gravel and crushed stone being 1500 tons per day.

The Russell-Greene Foell Company's Baldwin Park plant is also operated by the same company. Capacity 2000 tons per day.

The two plants of the Pacific Rock and Gravel Company located on the San Gabriel Wash near Azusa are operated by the Union Rock Company. Capacity of each plant being 2000 tons of crushed rock, sand and gravel per day.

In Los Angeles a rock crushing plant is operated on the gravels of the Arroyo Seco by the Los Angeles Rock and Gravel Company at Avenue 35 and Pasadena avenue. Ten men employed.

For detailed description of quarries and plants see Report XV, pp. 481-488.

ORANGE COUNTY.

Orange County stood second in the list of mineral producing counties of California for the year 1919, due to its highly productive oil fields.

Other items yielding in commercial quantities are: Clay products, natural gas and miscellaneous stone.

Aside from the substances actually produced it contains deposits of coal, gold, gypsum, iron, infusorial earth, sandstone, silver-lead, and tourmaline.

CLAY.

On the west side of the Santa Ana Range are deposits of clay which are the equal of those of the Temescal Valley in quality and commercial value.

The brick plants under operation in the county were: La Bolsa Tile Company, office and works at Smeltzer; Santa Ana Brick Works, in Santa Ana.

The Los Angeles Pressed Brick Company shipped clay from the company's deposit near Prado, a station on the Santa Fe Railroad, to the Los Angeles plant.

Bibl.: Preliminary Report No. 7, pp. 66-67, "The Clay Industry in California."

PETROLEUM AND NATURAL GAS.

Orange County production of petroleum for year 1919 amounted to 14,458,722 bbls., valued at $26,893,223. In addition to this, natural gas was reported to amount to 12,039,355 M. cu. ft., valued at $837,439.

Since the Fifteenth Report of the State Mineralogist was published two new and productive oil fields have been discovered in Orange County, namely, Richfield and Huntington Beach. The last being the most recent and important oil discovery in California, as the nearest producing field is in the Coyote Hills, 17 miles to the north. Several very productive wells have ben completed and a dozen or more wells are in the process of drilling within an area some ten miles long and two to three miles wide.

For detailed description of the different oil fields of the county see Bulletin No. 69, "Petroleum Industry of California"; also State Oil and Gas Supervisor's Annual Reports Nos. 1, 2, 3, 4, 5, and 6.

References: Bull. 19, pp. 57–61, 79–82, 77, 180; Bull. 32, p. 20; Bull. 63, p. 334; Bull. 69, pp. 118, 308, 350, 366, 503.

SILVER-LEAD.

Silverado Mine. It is situated in Silverado Cañon, 20 miles east of Santa Ana. Elevation 2300 feet. Claims: Dunlap, Blue Light, Harvey-Blue Light and Flannagan Blue Light. The vein occurs in metamorphoric rocks. Width 2 to 4 feet. The ore is silver-bearing galena, associated with zinc-blende and iron pyrite. Developments consist of a series of adits on the vein. The ore milled is stated to carry .06 ozs. gold, 12.6 ozs. silver, 3% lead and 14% zinc. Some development work was done on the property and a 50-ton concentration plant was installed. Idle. Owner, Blue Light Mining Company; W. H. Tharp, 746 South Bonnie Brae street, Los Angeles, California.

RIVERSIDE COUNTY.

Riverside is the fourth county in the state in size and the thirteenth in regard to the total value of the mineral output for 1919. Within its borders are included mountain, desert and agricultural land. Its mineral resources include metals, structural and industrial materials and salines. In point of variety Riverside County led all others with nineteen different minerals commercially produced in 1919, surpassing San Bernardino County. The total commercial production for the year was valued at $2,578,250.

Since the Fifteenth Report of the State Mineralogist was issued there has been very little activity in metal mining in the county, and most of its production has been from structural and industrial materials. The work covered in this report has been in visiting the districts throughout the county during the years 1919-1920 that have been active in development in industrial materials. Therefore only those deposits that were under active operation or which have not been reported on in previous reports will be discussed in detail.

ANTIMONY.

Crowell Mine. Five miles southwest of Corona, at elevation, at 1700 feet. The ore, stibnite, occurs in irregular bunches in a mass of shallow rock. J. Crowell, owner.

Bibl.: Report XIII, p. 31.

ASBESTOS.

The occurrence of asbestos is also reported 15 miles south of Palm Springs, in the Santa Rosa Mountains.

Bibl.: Fifteenth Report.

CEMENT.

Riverside Portland Cement Company. Tyler Henshaw, president; W. H. Metcalf, secretary; corporation office, Mills Building, San Fran-

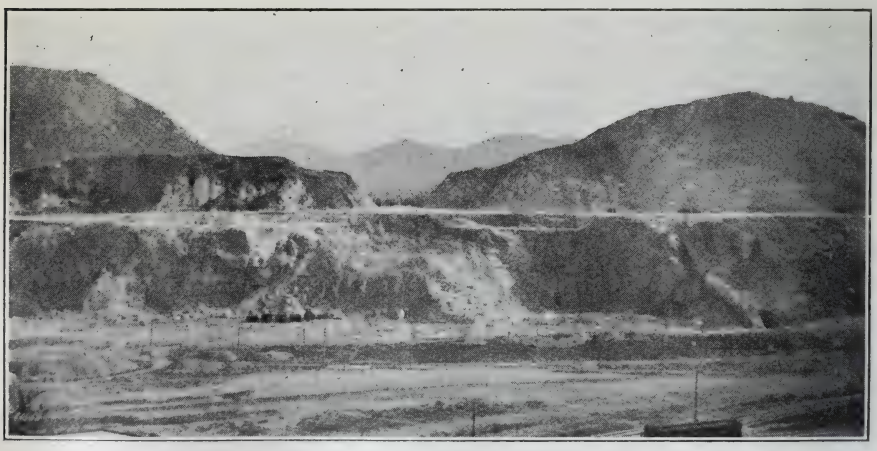


Photo No. 39. Quarry, Riverside Portland Cement Company, Riverside County, California.

cisco, California; John Treanor, manager; business office, Title Insurance Building, Los Angeles, California.

Quarry and plant 5 miles northwest of Riverside. The limestone is in two beds separated by quartzite. The strike is northeast and dip is 25 degrees SE. Limestone coarsely crystalline, said to be high grade, running 98% pure. Underlying limestone is a mica diorite, which is quarried to supply the aluminous material for the cement. Besides output of cement, company also produces potash.

Cement plant is being operated to capacity. Capacity of plant 2,000,000 bbls. yearly. Seven hundred men are employed.

Bibl.: Rept. XV, pp. 553-559.

CLAY.

Brick clays, in this county as elsewhere, occur locally at many points, and are not of great commercial importance, but the most prominent member of the nonmetallic group is found in the plastic clay of the Temescal Valley.

Plastic Clays of Riverside County. In western Riverside County, extending along the Temescal Valley for 10 miles, from Elsinore on the southeast to and beyond Corona on the northwest, is a zone of plastic clays of superior quality. The extent and thickness of these clays, together with the great plasticity of some and high refractory quality of others, give them much importance, and these deposits will grow in commercial prominence as the population of Southern California increases and the transportation lines are further developed. Many openings have been made in these beds at different points from which, during a number of years, clay has been taken for factories at Alberhill, Elsinore, Corona and Los Angeles.

Alberhill Coal and Clay Company, J. H. Hill, president; G. C. Hill, secretary; office, Equitable Bank Building, Los Angeles, is the largest producer of different varieties of clays in the county.

The greatest amount of the clays produced is being mined in the main tunnel pit by the Los Angeles Pressed Brick Company for its plant at Alberhill. The production from this property amounts to 70,000 to 75,000 tons yearly.

For detailed description of the different deposits see Report XV, pp. 559-574. Also, Preliminary Report No. 7, "The Clay Industry in California," pp. 74-91.

COAL.

Alberhill Coal and Clay Company shipped some coal from its holdings at Alberhill in past years. The coal beds have recently been reopened and a small amount mined. However, work is confined almost entirely to mining clay. Report XV, p. 574.

There is a deposit of coal on Hoag Ranch, south of Corona, west of Joseph Cañon. The vein is 4 ft. wide.

COPPER.

This metal is rather widely distributed in Riverside County, and the principal deposits, which lie eastward towards the Colorado River, are in the Ironwood or McCoy Mountains.

Ironwood or McCoy Mountain District. This district contains a mineralized zone of copper, silver, gold and lead ores. High grade sulphide deposits exist, principally in the form of lenses or kidneys. Besides these, native copper is occasionally found. The district is 22 miles from the Colorado River and about 20 miles southwest of Blythe Junction on the Santa Fe Railroad.

Copper ores also occur in the Palen Mountains, and a number of promising looking prospects are being developed. There ore is principally the oxides of copper, which carry values in gold and silver.

See Report XV. pp. 524-527.

GOLD.

This precious metal is sparsely and widely distributed in Riverside County, and many gold mining districts have been recorded; few of them, however, with any large production. The principal occurrence of gold-bearing quartz veins are found in the region near Perris and Elsinore, and in the eastern desert area between the San Bernardino Range and the Colorado River.

There is no activity throughout the county in gold mining, due principally to the high cost of labor and material.

Bibl.: Rept. XV, pp. 527-544.

GYPSUM.

Gypsite occurs in several small areas on both sides of Gypsum Cañon, about 2 miles south of Corona. The larger deposits are on the east side of the Cañon, a short distance from its mouth. Other small deposits are said to occur in neighboring cañons west and southwest of Corona. This material is used in orchards as a fertilizer, and to prevent disease. The deposits have not been worked for the past two years.

Extensive deposits of gypsum occur in the northeastern desert section of the county, in the Palen Mountains, and Maria Mountains.

Palen Mountain Deposits. Extensive deposits of gypsum occur in the Palen Mountains, north of Packards well, and 15 miles southwest of the Parker cut-off of Atchison, Topeka and Santa Fe Railroad. The gypsum is very pure, occurring in extensive layers interbedded with limestone. Most of it is finely crystalline and compact and varies in color from transparent white to slightly reddish. The beds have a maximum thickness of several hundred feet, with little or no interbedded limestone; the entire series of interbedded limestone and gypsum is probably several thousand feet in thickness. The belt of gypsum and limestone is about 3 miles long and one mile wide. It runs across the Palen Mountains in a general east and west direction, and disappears under the unconsolidated desert deposits on both sides.

The gypsum beds are the largest and most abundant in the southern part of the belt. The strike of the beds range east to northeast and dip north at different angles. A dark igneous rock occurs extensively as an intrusive within the area of gypsum and limestone, being especially abundant in the northern half of the belt. Reported that these deposits are to be developed by Joe Montgomery, and associates, of

Los Angeles Investment Building, Los Angeles, California. The company will be known as the Standard Gypsum Company.

Bibl.: U. S. G. S. Bull. 430, pp. 407-416, 1910. U. S. G. S. Bull. 697, pp. 78. (Footnote extracts made from these reports.)

Maria Mountains Deposits. These deposits are located in the Maria Mountains about 17 miles south of Blythe Junction, a station on the Parker cut-off of the Santa Fe Railroad. The principal deposits are owned by the United States Gypsum Company, 200 Monroe Street, Chicago, Illinois; president, S. L. Avery.

The gypsum claims of the company are in the southwest corner of township 3 S., R. 21 E., and the northwest and southeast corners of township 4 S., R. 21 E., S. B. M. The gypsum occurs in beds that have a general east and west course and a northerly dip, which ranges at the outcrop from 20 degrees to almost vertical.

The gypsum beds range in thickness from 10 to more than 100 feet, and are interbedded with limestone or shaly material. They occur in two bands of four beds each. The thickness of limestone between the gypsum beds is from 100 to several hundred feet. Most of the gypsum is snowy white; some of it, however, has a grayish tint. Shafts and numerous drill holes have been put down by the United States Gypsum Company to determine thickness of beds.

Bibl.: Spurr Gordon. Gypsum in the Maria Mountains, Riverside County. Mining World, Vol. 34, pp. 787-790, 1911. Bull. U. S. G. S., 697, p. 79.

IRON.

The largest and most important deposit of iron ore in the state occurs in Riverside County. These deposits are in the northern part of Eagle Mountains, in the central part of the county, township 4 S., A. 14 E., about 40 miles northeast of Mecca, on the Southern Pacific Railroad, also 45 miles south of Cadiz, on the main line of the Santa Fe Railroad. The ore is mostly hematite, but here and there consists of magnetite. A considerable percentage of the iron ores of these deposits are said to be very pure, containing from 62% to 67% metallic iron. For detailed description of these deposits see U. S. G. S. Bulletin No. 503, by E. C. Harder, 1909.

MAGNESITE.

Hemet Magnesite Mine. The mine is situated 3½ miles north of Winchester in section 31, T. 5 S., R. 1 W. Magnesite occurs as a stock work of veins in a zone of serpentine about 200 feet wide, extending northwestward for probably 1000 feet. The deposit is developed by large open cut, or glory hole. A crosscut tunnel at lower elevation is connected with glory hole by a series of raises. Ore from tunnel level is carried by system of belt conveyors to a sorting plant equipped with a 36-foot belt, 3 feet wide. Magnesite conveyed to a screen where it is washed and the fines rejected. Washed magnesite burned in a 6′ x 60′ rotary calciner, then distributed to cooling bins by a drag conveyor. Finally ground to pass 100 mesh screen. Capacity of plant 30

tons per day. When operating, 35 men are employed. Idle. Owner, Magnesco Refractory Products Company; Wellman Lewis Company, Hibernian Bank Building, Los Angeles, California.

Bibl.: U. S. G. S. Bull. 355,. pp. 38-39.

MANGANESE.

Manganese deposits occur in a small area in the northern part of the Ironwood Mountains, and in the west end of the Maria Mountains, in Riverside County, both areas in the Ironwood district.

The deposits in the Ironwood Mountains are included in the Black Jack, Melville and the Social Claim groups.

In the Maria Mountains ore has been produced from the Dioxide, but adjoining are a number of undeveloped claims.

Photo No. 40. Hemet Magnesite Mine, Winchester, Riverside County.

A group of claims of the United States Gypsum Company lies north of the Dioxide group. The deposits are accessible by roads that lead from Brown's and from English Siding, points on the Southern California Railroad.

The deposits in the Ironwood Mountains are 10 miles west of Brown's Siding; those in the Maria Mountains are 5 miles west of English Siding.

Most of the ore shipped in this district in 1917 and 1918 contained over 40 per cent. manganese, from 0.5 to 2 per cent. of iron, and from 3 to 8 per cent. of silica. The manganese deposits of the Ironwood Mountains are contained in veins or shear zones that cut a sheared and intrusive igneous rock. Veins strike north and south and have steep dips.

The manganese deposits in the Little Maria Mountains are contained in a wide zone of brecciation in massive limestone and in quartzite. The zone of brecciation strikes N. 60° W.

The manganese deposits consist of the oxides psilomelane, and pyrolusite. Calcite occurs in all the deposits, but is more abundant in some of the veins than others.

For full description of the different deposits see Cal. State Min. Bur. Bulletin No. 76, pp. 54-59, "Manganese and Chromium," U. S. G. S. Bulletin 710-E. pp. 193-200.

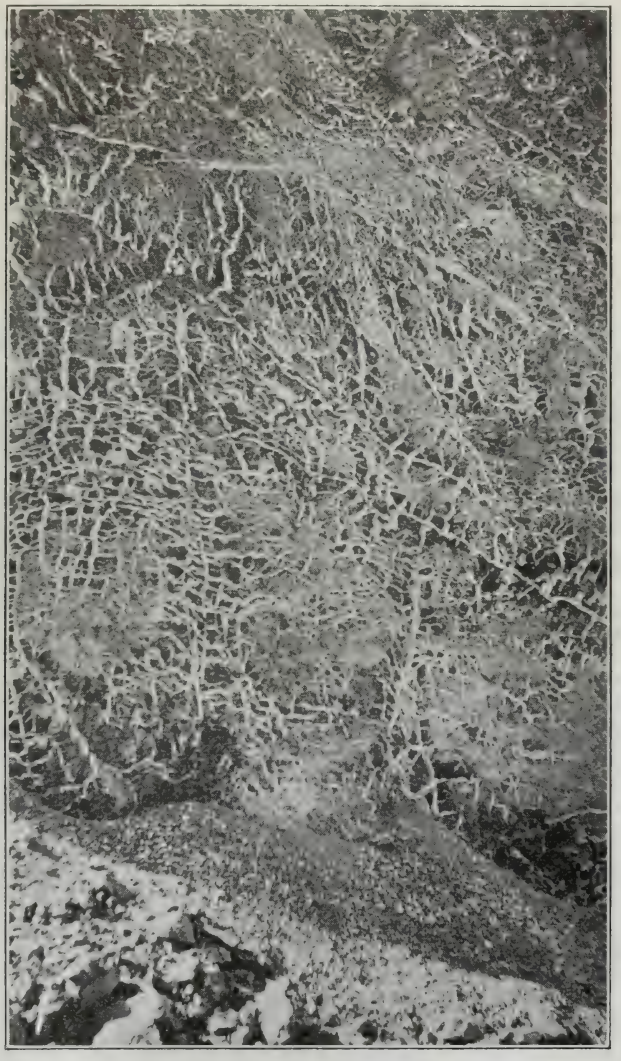


Photo No. 41. Hemet magnesite mine, showing stockwork of veinlets of magnesite. This whole face is mined and the magnesite hand-sorted on a picking belt.

MINERAL SPRINGS.

Among the natural resources of Riverside County, are a number of mineral springs, which are of commercial importance, owing to their curative properties. The most noted being at Glen Ivy, Elsinore, and Murrietta.

For detailed description of the various mineral springs throughout the county, see U. S. G. S. Water Supply Paper No. 338, by Gerald Waring, 1915.

SALINE DEPOSITS.

Borax is known to occur in the eastern end of Riverside County, in the Salton Sea basin. But no deposits of commercial importance have been developed in this area.

SALT.

The salt beds of Salton Sea area near Salton are of commercial importance, and in the past have produced large amounts of very pure salt. Sodium chloride 94.68 to 97.76%, and free from organic matter. See Bulletin No. 24, "Saline Deposits of California," by Gilbert E. Bailey, pp. 122-126.

SILICA AND FELDSPAR.

There are extensive deposits of silica and feldspar throughout Riverside County, the most important being in the neighborhood of Hemet, Lakeview, Nuevo, Perris and Murrietta. The commercial importance of these deposits has been recently augmented by increased demand for these materials by the clay manufacturers, and Glass Works of Los Angeles, California.

Silica and feldspar are described together, as they are as a rule associated together in the different deposits mentioned.

Hemet Silica Mine. The mine is situated 2½ miles south of Hemet, on the southwest slope of Polly Butte, in section 27, T. 5 S., R. 1 W. Elevation 1850 feet.

A massive outcrop of quartz occurs in the granite on the southwest slope of low granite hills. There are also a series of lenses of quartz in the granite. The general strike of these lenses is north and south with a dip of 80 degrees east; the massive outcrops can be traced on the surface for 500 to 1000 feet. The main lens of quartz is 75 to 125 feet wide. There is an open cut on this lens on north slope of hill, 25 feet by 50 feet in length, exposing 75 feet of pure white quartz. At an elevation of 1850 feet a tunnel is driven under the massive outcrop of quartz, a distance of 200 feet. About 30 feet from the portal of the tunnel, a lens of quartz was cut 40 feet in thickness; it lies parallel to main quartz lens, there being a belt of granite between these deposits. The silica so far developed on these deposits is very white and pure, but shows in places a small amount of iron stain and some mica. A large tonnage has been developed, and the owners plan to build a grinding plant at Hemet.

Owner, Hemet Silica Company, H. H. Spaulding, president; Benjamin Oakford, secretary; William G. Preston, manager; Offices, Los Angeles Investment Building, Los Angeles, California.

Nuevo Silica Mine. The deposit is situated 4 miles south of Lakeview on the Santa Fe Railroad.

A large outcrop of silica and feldspar occurs in the low lying granite hills south of Lakeview Valley. The strike of the outcrop is NW. and

SE. dip 60 degrees SW. On the surface the outcrop of silica and feldspar is 150 feet wide, and can be traced for a length of 200 feet. Intermixture of silica and feldspar occur together which can be mined separately, as the dividing line of demarcation is very distinct. In an open cut 150 feet wide by 45 feet in length, there is a capping of feldspar 30 feet thick overlying 15 feet of silica. The feldspar is of fine quality containing 11% potash. The silica is clear and white. Four men are employed. A large tonnage is being shipped to the company's plant in Vernon. Owner, American Encaustic Tiling Company, Los Angeles, California.

Warren Feldspar and Silica Deposit. The deposits are located on the Warren Ranch, 3 miles east of Lakeview. Series of parallel ledges of feldspar and silica occur in the granite. These veins of quartz have a general northerly and southerly strike, and can be traced on the surface for a distance of ¾ of a mile. On the northern part of the ranch there are four parallel veins. Only a small amount of surface prospecting has been done on the different outcrops, consisting mostly of shallow cuts. The feldspar and silica are of good grade, show only a small amount of impurities. Reported that the feldspar will carry 10% potash. Silica runs 98% pure. From surface indication a large tonnage of both materials can be developed. The deposits lie 2 miles east of the American Encaustic Tile Company's Nuevo deposit, and the mode of occurrence is similar. Owner, George R. Warren, 1173 West Tenth street, Riverside, California.

M. L. Cambern and **A. Schneider** of Elsinore own a feldspar and silica deposit 3½ miles northeast of Murrietta. Massive quartz outcrop in granite, stated to have a width of 25 feet. The silica and feldspar are associated together. Silica pure white, with only small amount of impurities. Feldspar of good quality and said to have a potash content of 10%.

E. T. Green of San Jacinto owns a silica deposit in Bautiste Cañon, 8 miles southeast of San Jacinto. Outcrop stated to be 12 feet wide. Silica is white in color, and said to analyze 98% pure.

STONE INDUSTRY.

Granite is widely distributed over Riverside County. It has been quarried on a large scale, at Casa Blanca, for rubble, and for building and ornamental purposes at Corona, Riverside, and Temecula. At Porphyry and Riverside it has been quarried for broken stone.

The Corona granite is used to some extent for building stone, and in considerable quantities for monumental work.

A number of quarries are being reopened near Corona, Temecula, and Perris on account of the increased demand for building material.

For detailed description of deposits see Report XV, pp. 584, 585, 586.

CRUSHED ROCK.

Temescal Rock Quarry. The quarry is located in Temescal Cañon, 4 miles southeast of Corona. The material that is being crushed is a rhyolitic porphyry, and is very hard and sharp. The quarry has been recently purchased by the Blue Diamond Plaster Co., offices 2200 East

Sixteenth street, Los Angeles. W. H. Hay, president and general manager. This company plans to operate the quarry on a large scale.

For detailed description see Report XV, pp. 586, 587.

SLATE.

Rainbow Mining and Mineral Products Company. M. L. Cambern, president; A. Weinman, secretary; A. Hart, general manager; offices, H. W. Hellman Building, Los Angeles, California. Are mining and crushing green and red slates for roofing purposes. The property is known as the Rainbow group of mines, and is situated 3 miles north of Elsinore.

The general strike of the dark siliceous slate belt is N. 40° W. dip 50° SW. In this belt are a series of parallel veins of green slates which have an average width of 6 to 8 feet. On the northwest end of the property are found belts of brown, red and yellow colored slates. It is stated that 12 different colored products can be made for roofing purposes. Developments consist of tunnels and open cuts on the different veins.

A 20-ton grinding plant has been installed on the property. Ore from different openings goes to 12″ x 16″ Wheeling crusher, where crushed to $\frac{1}{4}$ mesh. The product from crusher passes through a 10-mesh rotary screen with a dust jacket of 20 mesh. Oversize from this screen returned to 12″ x 20″ Stearns-Rogers rolls, while through size passes over Newago screen of 20 mesh. Then product goes to storage bins. 10 on 20 mesh product is shipped to Los Angeles for roofing purposes. Company is at present shipping 5 cars per week. Capacity of mill is 30 tons per day. Ten men are employed.

TIN.

The **Temescal Tin Mine** is located in the western part of Sobrante de San Jacinto grant, and about 5 miles southeast of Corona. These deposits have not been worked for a number of years.

Detailed descriptions of these deposits are given in the following reports: Reports IV, p. 120; XI, pp. 111–113. Also in American Journal of Science, 4th Series, Vol. IV, pp. 39–42.

Other references will be found in Mineral Resources of the United States, U. S. G. Survey, 1882, p. 434; 1891, p. 161. Also, U. S. G. S. Bull. 260, and U. S. G. S. Sixteenth Annual Report, 1894, Part III, p. 536.

ZINC.

Palisade Zinc Mine. It is located 25 miles north of Blythe in Maria Mountains, about 2 miles from English siding on California Southern Railroad. Deposit of zinc carbonate ore, associated with copper and lead, is being developed. Shaft 100 feet deep. A. W. Hansen and A. Villman of Blythe, owners.

SAN BERNARDINO COUNTY.

San Bernardino County, by far the largest county in the state, in area, has more diversified mineral wealth than any other portion of California. San Bernardino for several years led all other counties in the state in point of variety of minerals produced. Although its area is comprised largely of rugged mountains and desert waste, it is highly mineralized, the following being included among its mineral resources: Asbestos, barytes, borax, brick, cement, clay, copper, gems, gold, granite, gypsum, iron, lead, limestone, manganese, marble, niter, potash, salt, glass-sand, soapstone, soda, strontium, talc, tungsten, vanadium, and zinc.

Within its borders are found a wide range of geological formation from Paleozoic to Tertiary, and a great variety of rocks of igneous origin.

The mines are scattered all over its thousands of square miles of territory, and have already added millions of dollars to the wealth of the state. Many of the mines are of phenominal richness, and were it not for the expense and extreme difficulty attending transportation in the desert, San Bernardino County would undoubtedly take first place in adding to the mineral wealth of California.

TRANSPORTATION.

The county has the advantage of direct communication with the principal trade centers by means of the Santa Fe, the Salt Lake, the Southern Pacific, and the Tonopah and Tidewater railroads. From the different railroad points there are automobile and wagon roads to the various mining districts. Transportation difficulties on this desert country have been greatly facilitated by use of automobiles and trucks.

MINERAL RESOURCES.

Since the Fifteenth Report of the State Mineralogist the most noteworthy developments that have taken place in the county are the completion of three large plants on Searles Lake for the extraction of potash from the brines of the lake.

With the increase in the price of silver there has been renewed activity in the old silver camps of the county, this especially being true of the Calico mining district. However, the most important development was the discovery of high-grade silver ore in the Rand mining district, near Atolia, by John W. Kelley, H. Williams, and Jack Nosser. These parties opened up and developed the California-Rand silver mine, commencing operations in May, 1919. Since that date the property has produced in the neighborhood of $1,000,000.

Owing to the present low market price for tungsten, all the mines in the Atolia district were compelled to close down during the latter part of 1918. Practically all the gold mines throughout the county have suspended operations due to the high cost of material and labor.

In the following report on the mineral resources of the county only the mines and deposits that are in active operation, or which were not previously reported on, will be discussed:

ASBESTOS.

The occurrence of asbestos is reported about 4 miles west of Cottonwood, a station on the Santa Fe Railway. The asbestos is stated to occur in a seam in a shale country rock, about 4 feet wide.

Bibl.: Bull. 38, p. 263.

BARITES.

Barium Queen Mine. It is situated 5 miles northeast of Barstow, on south slope of low range of hills north of Mojave River, in township 10 N., R. 1 W. Holdings consist of three claims—Barium Queen, White House, and White House Extension. Barite occurs in series of parallel veins, which strike N. 30 W., and dip 70 degrees NE., cutting quartzite and schist. The main vein can be traced on the surface for 4500 feet, is 4 to 5 feet wide. It has been developed along its strike by a number of open cuts and prospect holes. At an elevation of 2950 feet, a tunnel has been driven on the vein for a distance of 200 feet; in this tunnel the vein has an average width of 4 feet. Barytes is white in color, but slightly iron stained on the surface. Samples taken from vein in the tunnel reported to assay 85% barium sulphate, no lime, and the balance of the gangue being principally silica. Possible to develop a large tonnage of barytes on the property. Idle. Owners, Ellis Mallery, and Chas. Mushrush, 214 H. W. Hellman Building, Los Angeles, California.

Foshay Pass Barite Deposit. The deposit is located in Foshay Pass, 26 miles southeast of Kelso, a station on the Salt Lake Railroad. Elevation, 3900 feet. Holdings consist of 8 claims, three claims in length along the deposit. Series of parallel veins of barite occur in the granite, general strike of the veins being NE. and SW., with vertical dips. Width of veins being from mere stringers to 12 inches. Reported to assay 85% barium sulphate, low in silica, with some lime present. The barite is pure white in color, showing no iron present. Idle. Owners, Thomas Gannon, and A. A. Irish of Fenner, California.

Mansfield Barite Deposit. The deposit is six miles north of Barstow. The barite is deposited in a vein averaging 3 feet wide in limestone. The vein can be traced for 2000 feet. Developments consist of a number of prospect holes sunk at different points along the outcrop. The barite is white in color, but slightly stained with iron. Several other deposits are reported in that vicinity, none of which have been developed. Idle.

Bibl.: 38, p. 264. XV Report, p. 853.

J. H. Massen is opening up a deposit of barite, 2 miles southeast of Afton, a station on the San Pedro and Salt Lake Railroad. Small stringers of barite occur on the contact of limestone and schist. Width 2″ to 6″. Barite is of good quality.

M. Pluth, of Daggett, owns a deposit of barite 4 miles north of Daggett; barite is deposited in vein 4 feet wide. Color white, and free from iron.

A. C. Pierce, of Long Beach, California, owns a group of claims twelve miles east of Victorville. On east and west fracture in limestone barite occurs as filling stained with copper.

BORAX.

The production of borax in San Bernardino County was for many years its leading industry, but with the exhaustion of the colemanite mines of the Pacific Coast Borax Company near Calico in 1904 it practically ceased.

At present writing borax is being shipped from the Neil borate mine by D. D. Connell of Yermo, California, who is working the property under contract. About 200 tons per month is being shipped to the refinery at Bayonne, New Jersey, from Daggett.

Bibl.: Repts. IX, p. 225; XI, p. 345; XII, p. 35; XIII, p. 46; XV, p. 853. Bull. 24, pp. 56-60.

Union Borax Company, 328 I. W. Hellman Building, Los Angeles, M. Blumenthal, president; Harry F. Miller, secretary, are opening a borax deposit adjoining the Neil borate mine, 8 miles northeast of Yermo, a station on the Salt Lake Railroad. The company is sinking a shaft, with the idea of developing the same ore body that proved so productive on the Neil borate mine.

There are many other deposits, most of which are low grade, marsh or playa deposits which could not compete with the colemanite deposits of Inyo, Los Angeles, and Ventura counties, and there has been no recent work done on them.

Bibl.: Repts. IX, p. 225; XI, p. 345; XXII, p. 35; XIII, p. 46; XV, pp. 853-856. Bull. 24, pp. 56-60.

Borax is being produced as a by-product by the different potash plants on Searles Lake; otherwise there is no development being done on the borax beds of the lake.

Bibl.: Rept. X, pp. 534-539. Bull. 24, pp. 63-65. U. S. G. S. Bull. 580-L. Rept. XV, pp. 853, 854.

CEMENT.

Colton Cement Plant, in sections 19, and 30, T. 1 S., R. 4 W., S. B. B. and M. The plant is operated by the California Portland Cement Company, Douglas Building, Los Angeles; Dan Murphy, president; T. J. Fleming, secretary and general manager; E. J. Strock, superintendent at plant.

The works are about 1¼ miles west of Colton, at the north end of Slover Mountain, south of the Southern Pacific Railroad.

Slover Mountain is a knoll of crystalline limestone, about a mile long, more than half a mile wide, and 500 feet high. Analysis of the limestone shows it to be very nearly pure carbonate of lime. One analysis gave:

Lime	55.216%
Carbon dioxide	43.384%
Silica	0.550%
Alumina and Iron Oxide	0.850%

The composition of the stone in quarry is said to be very uniform. A tunnel has been driven through the mountain from the level of the quarry floor to a point directly above the old cement works, and the broken rock is trammed through the tunnel and dumped into a rock

crusher. After crushing, goes to Griffin mill, where finely pulverized, then thoroughly mixed with clay in a mixer. The mixed product is fed into eight rotary kilns, where it is burned to a clinker with an oil fire. The clinker is spread out and sprinkled with water, for the double purpose of cooling and seasoning it. It is then ground in Griffin mills and tube mills and sacked for shipment. Besides cement, the company produces crushed stone, lime, potash, and marble dust for making carbon dioxide gas for soda fountains. Capacity of plant is at present writing about 600 bbls. per day; 75 to 100 men are employed.

Bibl.: Repts. XII, p. 380; XV, pp. 857, 858.

Golden State Portland Cement Company, F. O. Wyman, president; C. W. Russell, secretary and general manager; J. A. Wilson, superintendent; offices, 915 Marsh-Strong Building, Los Angeles. The plant is at Oro Grande, and the quarries are four miles east of plant. The rock is transported from the quarries to the plant over a railway owned by the company. Method of treatment is by the dry process. Limestone from quarries goes to No. 7 gyratory crusher, while shale rock from the shale quarry (on the company's holdings) goes to 11″ x 22″ Blake crusher. Crushed shale and limestone elevated to separate bins (capacity of shale bins 700 tons, bins for limestone having a capacity of 1300 tons). Material from bins passes through two 40′ x 4′ rotary kilns (one for shale, the other for limestone), where the moisture is driven off. From these kilns the product goes to preliminary ball mills, two mills used for grinding lime rock and one for shale. The ground product from these mills elevated to separate bins. Drawn off from these bins, weighed and mixed. The mixed product goes to two 16′ x 8′ tube mills, where ground so that 90% will pass 200-mesh screen. The mixed product is fed into a rotary kiln (125 feet long by 8 feet in diameter), where it is burned to clinker with an oil fire. The clinker from kiln is spread out and sprinkled with water, then conveyed to storage bins having a capacity of 70,000 bbls. Clinker is ground in two ball mills, the product from ball mills is fed to 3 tube mills (16′ long by 8′ diam.), where reground so that 99% will pass through 100 mesh. This finished product goes to Bates sacker machine, and sacked for shipment. Capacity of plant is 600 barrels of cement per day. Twenty-four men are employed at the quarries, and 54 men at the plant. Electric power is furnished by the Southern Sierras Power Company. Combined horsepower of plant is 1800 h.p.

This plant resumed operations after a long shutdown, and are now operating to full capacity.

Bibl.: Rept. XV, pp. 858, 859.

Riverside Portland Cement Company, office, Title Insurance Building, Los Angeles, owns extensive deposits of limestone, shales and silica, said to be suitable for the manufacture of Portland cement, in the vicinity of Oro Grande and Victorville, which will ultimately be worked when their Riverside deposits are exhausted.

Bibl.: Rept. XV, p. 859.

Southwestern Portland Cement Company, C. Leonard, president; O. J. Benford, secretary; general office, H. W. Hellman Building, Los Angeles; L. D. Robinson, superintendent at plant; Frank Arnold, quarry superintendent. The company owns a deposit of limestone, shales and silica covering about 250 acres, 6 miles northeast of Victorville. The belt of limestone strikes N. 30° W., and dips 50° north overlying shales. The silica occurs as massive intrusions. The main quarry face has been opened for a length of 1500 feet, with a height of 300 to 400 feet. The rock is quarried by drilling with Keystone drills and blasting after springing round of holes, broken rock is handled with two Bucyros steam shovels, loaded into trains of 6 cars, and hauled over the Mojave Northern Railroad to the plant near Victorville.

Plant. Lime rock and shale dumped direct from cars into Allis-Chalmers Fremont rolls, which have a capacity of 1000 tons per 10 hrs. crushed to pass 10″ ring. Product from rolls to No. 7 Jumbo-Williams mill, is crushed to pass a 2½″ ring. The product from Williams mill elevated to four compartment storage bins (capacity 2000 tons). From these bins conveyed to bins over main grinding plant. Material fed by automatic feeders to one double tube mill (26′ long by 7′ diameter), crushed wet so that 90% of product will pass 200-mesh screen; other unit consists of 8′ x 5′ Ball mill, product from this ball mill to 18′ x 6′ tube mill. Material after passing through tube mills elevated and fed to 12 slurry tanks, then agitated with air to give the proper mix. The mixture from tanks goes to two rotary kilns. No. 1 kiln is 200′ long by 9′ diameter. No. 2 kiln is 200′ long by 9′ diameter at feed end, and 10.6′ at burning end, where it is burned to clinker with an oil fire. The gases generated in burning material pass through kilns at the rate of 1000 feet per minute. The gases after passage through kilns pass through dust chambers and then out through stack 187 feet high. The dust from dust chambers drawn off by screw conveyors and returned to kilns. Clinker from two kilns drops into hopper below the kilns, where water is added to cool the material, also set the cement. Clinker then elevated to storage bins, where distributed by Brown crane hoist into large storage bins. From these storage bins the clinker is elevated to top of plant, where gypsum is added, then passes through 18′ x 6′ tube mill for regrinding, the ground product from this mill is elevated to an Emerick separator, finished product is separated out, and goes to four concrete storage tanks (capacity 8000 barrels each), oversize returned to tube mill and ground so that 87% passes through 200-mesh screen. From storage tanks finished product goes to Bates packer machines, where sacked and stored in warehouse for shipment. The capacity of the plant is 2000 barrels per day. One hundred men are employed at the plant, with 20 men at quarries. The plant is operated by electric power supplied by the Southern Sierras Power Company. The plant is built entirely of reinforced concrete, and is the most up-to-date cement plant on the Pacific Coast. The wet process is used in the manufacture of cement, which is much more economical than the dry process.

Bibl.: Rept. XV, pp. 859, 860.

CLAY.

There are extensive deposits of brick and high-grade clays in the county, most of which have never been developed, owing to their distance from manufacturing centers. During 1920, owing to the demand for clay suitable for use in filtering and purifying oils, there has been quite an interest created in looking for clays suitable for this purpose, also a demand for high-grade kaolin for pottery.

From four to ten miles east of Oro Grande and Victorville are a number of undeveloped deposits of clay and kaolin. See Report XV, pp. 860-861; Bull. 38, pp. 126-7.

G. J. Lingenfelder and **R. H. Grear**, Daggett, own a bed of clay, 12 miles northeast of Barstow.

Bibl.: Rept. XV, p. 861.

California Master Products Company, 5826 South Main street, Los Angeles, are developing a clay deposit, in section 6, T. 11 N., R. 3 W., about $1\frac{1}{4}$ miles northeast of Daggett. The clay is white in color and said to be high in aluminum, having soapy feel. Probably a halloysite. Beds are reported to be from 4 to 10 feet thick. Six claims have been located. One car has been shipped. The material is said to be suitable as a base for cleaning compounds.

M. Mulcahy and **Mrs. M. Falconer**, Daggett, own a deposit of clay in Calico district, 6 miles by road north of Daggett. Idle.

Bibl.: Rept. XV, p. 861.

Velvet White Filler Company, 615 Brockman Building, Los Angeles; A. L. Beardsley, president; A. B. Clark, secretary. This company owns a deposit of clay in the Silver Mountain district, $3\frac{1}{2}$ miles east of Oro Grande. The deposit consists of seams of white silica, talc and kaolin in an igneous formation. A plant has been built at Bryman Siding on the Santa Fe Railroad for treating the clay. The process is as follows: It is washed in tanks, and an inverted screw separates the clay from the sand, the clay floats into settling tanks, then into presses. It is subsequently dried by steam-heated dryers, reground and sacked. It is used for paint filler, sizing paper and some porcelain work. The quarry is operated in the winter months, while the plant is only operated during the summer months. The present capacity of this plant is about 15 tons per day. The company is planning to double the capacity of the plant. Five men are employed. E. H. Taylor, superintendent.

Bibl.: Rept. XV, pp. 861, 862.

COPPER.

Copper is widely distributed throughout the mountain ranges which traverse the Mojave Desert in this county.

The most important mining districts where copper ores have been mined in the past, are as follows: Ivanpah, Ibex, Old Dad Mountain, Ord Mountain, Signal, Silver Mountain, and Whipple. Due to low market prices there is practically no activity in mining of copper ores, and all the mines have suspended operations. Therefore only

those properties will be discussed that were operating since the Fifteenth Report of the State Mineralogist was published. The largest amount of copper produced has been from the Copper World mine in the Ivanpah district, and the Pacific Mines Corporation properties, seven miles south of Ludlow. Both of these properties operated until the latter part of 1918.

For information on the different copper mines of the county, see Bull. No. 50, pp. 326-339; Fifteenth Report, pp. 784-791.

Copper Bell Group, Monumental district, 12 miles northwest of Drennan Station on Arizona and California Railroad, 1 mile from Monumental Peak. Eight claims. Developments consist of over 1000 feet of tunnels, crosscuts on Copper Bell claim. Quartz veins in granite. Ore, copper with gold and silver values.

Copper World Mine, Ivanpah district, is in the Clark Mountains, 20 miles northwest of South Ivanpah, the terminus of a branch line of the Atchison, Topeka and Santa Fe Railroad, leaving the main line at Goffs. The elevation at the mine is 5180 feet.

The property, which includes four claims, was taken over by the Ivanpah Copper Company, and mining operations started in May, 1916, and was a steady producer until the early part of 1919, when forced to suspend operations on account of low market price of copper. The ore occurs in a broad mineralized zone at contact of porphyry and limestone. The porphyry is an intrusive into hard gray colored limestone, and the copper ores are found through the porphyry for a considerable distance from the contacts. The mineral bearing zone is about 200 feet wide in places. It consists of iron, silica, lime, decomposed portions of the inclosing rocks and veinlets of copper ore, mostly brown oxides, with occasional bunches of malachite and azurite. Very little sulphide ore has yet been encountered, occasionally small bunches of chalcopyrite ore found in the lowest workings. Recently some veinlets of cuprite have been found, but they are small and of rare occurrence. The ore is generally low grade, said to average throughout 2% copper. By sorting it is brought up to 4%, which is the average ore smelted. Development work consists of a series of large cuts extending from the top of ridge down to about 30 feet above the bottom of the gulch, a vertical distance of about 150 feet. A main tunnel driven at an elevation of 5180 feet has over 2000 feet of drifts and cross-cuts from it. Then there are three tunnels, one 45 feet above main tunnel, the others 70 and 120 feet below tunnel level. Most of the work is done above main tunnel and the ore body is stoped in places to the surface. Comparatively little work has been done on lower levels. The ore bodies are irregular; the richest bodies are usually found on the contact. Judging from the extent of the porphyritic intrusions, and the numerous croppings, undoubtedly large bodies of ore will be developed on the claims.

When property was under operation, the production from the mine was about 100 tons daily. The ore was hauled by tractor to the smelter at Valley Wells, five miles southwest of the mine. This plant is equipped with 100-ton capacity blast furnace for making matte. A 75-h.p. Diesel type Fairbanks-Morse engine supplies power pumps

as well as power for plant. Old slag dump containing 13,000 tons said to run 2 to 10% copper is also being treated. The smelter started operations in November, 1917. Charge is as follows: (1000 lbs. to charge) $\frac{1}{4}$ slag, $\frac{3}{4}$ ore, 13½% coke, 4% sulphur. Iron pyrite is obtained from Jerome, Arizona, and also from Francis copper mine, situated 4 miles southeast of Ames Station, on the Salt Lake Railroad. The average content of ore treated is 4% copper, 3 to 5 oz. silver and 0.04 to 0.10 oz. gold. Matte is hauled from smelter to Cima, a distance of 25 miles, and shipped to Salt Lake. Sixty men employed when operating. Idle. Owners, Ivanpah Copper Company; Dan Murphy, president; Godfrey Houlterhoff, secretary; Dr. C. D. Godshall, general manager.

Bibl.: Repts. XIII, p. 61, XV, p. 786. Bull. 50, pp. 326-328.

Columbia (Macedonia) Mine. Kelso mining district. It is 5 miles southeast of Ames, a station on the San Pedro and Salt Lake Railroad. On the southwest slope of Providence Mountains. Elevation 4600 feet. Holdings consist of 4 claims: Columbia, Columbia Extension, Columbia No. 2. Vein quartz 5 feet wide with diorite footwall and porphyry hanging wall, strikes N. 75° E., and dips 50 degrees SE. An incline shaft has been sunk on the vein to a depth of 350 feet, with drifts driven on the vein east and west on the following levels: 100′, 200′, and 300′. The quartz carries chalcopyrite, galena with gold and silver values. Gold values said to be from $4 to $8 per ton.

Equipment, 80-h.p. boiler, 25-h.p. steam hoist, Laidlaw-Dunn-Gordon compressor. Two 6″ Cameron pumps. Five-stamp mill. Idle. Adam Boech, 1736 Morgan Place, Los Angeles, owner.

Confidence Copper Mine. Kelso mining district. It is 4 miles southeast of Ames, a station of Salt Lake Railroad, on the southwest slope of Providence Range of mountains. Series of parallel true fissure veins cutting the granite. Strike east and west, with dips to south of 65 degrees. Veins have widths varying from 2 to 7 feet. On the Confidence vein an incline shaft has been sunk to a depth of 100 feet. Besides this shaft there are a number of shallow shafts and open cuts. The vein is highly mineralized with chalcopyrite, also contains hubnerite and wolframite, has an average width of 5 feet. The wolframite occurs in kidneys along the footwall of the vein. On the Confidence claim there are also a series of cross-veins which strike N. 30° E. and intersecting the main vein from the southwest. The ore mined is said to carry 4 to 6% copper, $8 in gold. Owners, Confidence Copper Mining Company; Edward Buett, president; Edward Bluett, Jr., secretary, Los Angeles, California.

Emperor Mine. Clark Mountain district, situated 25 miles north of Cima, on the west slope of Clark Mountain. Holdings consist of four claims. Elevation 5500 feet. The vein containing ores of copper and lead along contact of granitic-porphyry, intrusive in the limestone. General trend of ore body is little west of north, dip almost vertical. Ore consists of carbonates of lead and copper, carrying some silver. Width of ore body is from one foot to six feet. Development work consists of an open cut which was made along the outcrop for 50 feet. Fifty feet below is the upper tunnel. The tunnel was driven SE.

parallel to the vein for about 100 feet, then westward 20 feet cutting the vein. Then a drift was run NW. along the ore body 30 to 40 feet, and winze sunk 55 feet in it. The ore body was stoped out on both sides of winze throughout its depth. A lower tunnel was driven 125 feet vertically below upper tunnel, almost due south 187 feet, but did not reach the ore body. It is in hard gray limestone, and would probably have to be driven 50 feet further to cut contact. Ore shipped from these workings averaged about $40 per ton. Last car shipped ran: 5 to 6% copper, 11 to 12% lead, and 11 to 12 ozs. silver. Idle. Gus Hampstead of Nipton, California, owner.

Foster Copper Mines. Shadow Mountain district. These mines are situated 25 miles east of Silver Lake on the south slope of Shadow Mountain. A series of parallel veins carrying values in copper, gold and silver occur in porphyry and schist. The ore consists of chalcopyrite, axurite, malachite, and iron pyrites. Veins have a general north and south strike, and dip from 40 degrees west to vertical. Three shafts about 100 feet deep have been sunk on different veins, also number of short tunnels and prospect shafts. Main shaft has been sunk to a vertical depth of 125 feet. Equipment consists of 6-h.p. gasoline hoist, and 7″ x 6″ compressor. Twenty-two claims have been filed on by the company. Idle. Owner, Foster Mines Company; C. R. Foster, president and general manager, Cima, California.

Francis Copper Mine. Kelso district. It is 4 miles southeast of Ames, a station on the Salt Lake Railroad, on the southwest slope of Providence Mountains. Elevation 4350 feet. Vein occurs on porphyry-granite contact, which strikes N. 65° E., dip 80 degrees to NW. Ore occurs as chalcopyrite, galena with silver values. Stated to carry 3 to 4% copper, 6 to 12% lead, with 10 to 12 ozs. silver. Vein has an average width of 3 feet. A shaft has been sunk on the vein to a vertical depth of 100 feet, with drifts east and west on the vein at 25′, 45′ and 75′ levels. At elevation of shaft, a crosscut tunnel has been driven south 120 feet cutting a vein which strikes N. 40° E. Ore shoot developed on the 75-foot level is 125 feet long, 3 feet wide. Was shipping 30 tons per month of copper-lead-silver ore to the Ivanpah Copper Company's Smelter via Cima. Owner, Francis Copper Mining Company, Dr. L. D. Godshall, president; Godfrey Houlterhoff, secretary; Edward Bluett, superintendent; Los Angeles Trust and Savings Building, Los Angeles, California.

Hidden Treasure Copper Mine, Signal district, is 12 miles east of Goffs. Elevation 2450 feet. Ore occurs on contact of granite and schist. Strike N. 40° W. dip 45° SE. Width 2 to 4 feet. Porphyry dike on 6 eastern claims about 500 feet wide, with stringers of copper stained ore running throughout. Series of prospect holes and trenches have been made along this dike. Main shaft on vein 160 feet deep. Ore consists of oxides of copper, chalcopyrite, and iron pyrite. Idle. Owners, A. L. Morehead, and W. F. Chausse of Goffs.

Pacific Mines Corporation (Bagdad, Chase and **Roosevelt Mines).** Office, 120 Broadway, New York City; J. N. Beckley, president; J. H. Hobbs, secretary; Frank W. Royer, consulting engineer and manager. This company's property, consisting of 27 patented claims, is seven

miles due south of Ludlow. A railroad connects the mine with Ludlow. The ore is deposited in an igneous mineralized breccia, formed by a fault. This mineralized brecciated zone is highly siliceous. The brecciated zone strikes east and west, and dips 25 to 30 degrees north. Its average width is from 8 to 15 feet. It has been proven on the surface along its strike for 2000 feet. The footwall of this zone is monzonite, with rhyolite hanging wall. Ore body faulted by series of faults which strike north and south, and displace the ore from 100′ to 240′ in places. The ore is mainly chalcocite and pyrite, carrying 1% copper, 0.27 ozs. gold, and 5 ozs. silver, and is in a quartz-porphyry gangue. Developments consist of vertical shaft 400 feet deep, incline shaft 450 feet on 30 degree incline, also shafts of 200′, 140′ and 120′, respectively, all sunk on the ore body, with several thousand feet of levels, drifts and crosscuts. The shafts are all equipped with gasoline hoists. A 16″ x 14″ x 10″ Sullivan two-stage compressor supplies the necessary air for drills. It is reported that the developed ore reserves are 300,000 tons, having a value of $6 per ton. Before operations were suspended by the company a small flotation plant was installed, and the tests showed a recovery of 90% of gold, 40% of silver, and 95% of copper. When the property was under operation 100 tons per day were shipped to smelter at Clarkdale, Arizona. Idle.

Bibl.: Rept. XV, p. 790.

Stonewall Mine. Clark Mountain district. It is 12 miles northwest of Ivanpah, in Clark Mountains. Elevation 5000 feet. Holdings consist of 13 claims known as the Stonewall group. Ore bodies occur as irregular lenses in the limestone. Ore is lead-carbonate with bunches of galena. The mineralized zone strikes NW. and SE., with a dip of 45° to SW. Developments consist of tunnel 400 feet long, in which an ore shoot 90 feet in length and 3 feet wide developed. Ore reported to carry 4% copper, 35 to 40 ozs. silver. Owner, Benjamin Lawrence of Ivanpah.

DOLOMITE.

Joseph Scheerer of Victorville has a deposit of dolomite on his claims 5 miles east of Oro Grande. Report XV, pp. 878–879.

FELDSPAR.

Clement and Blackburn Feldspar Deposit. The deposit is situated 1½ miles south of Oro Grande. Seven claims have been filed on the deposit. Pegmatite dikes containing orthoclase feldspar occur in the granite. The dikes are said to be 3 to 10 feet wide, striking east and west, and of great continuity, running the full length of the claims. The feldspar is said to contain 11% K_2O. Idle. Owner, Mrs. Ada Clement of Pleasanton, California.

J. H. Sloan, Barstow, owns a deposit 3½ miles north of Hinkley Station on Santa Fe Railroad. Idle.

Bibl.: Report XV, pp. 862–863.

FLUORSPAR.

Massen Fluorspar Deposit. It is situated 3 miles southeast of Afton, a station on the Salt Lake Railroad, in Cave Cañon mining district. Elevation 2100 feet. Holdings consist of 18 claims.

Fluorspar occurs in stringers and veins in a feldsitic rock. The deposit consists of a series of parallel veins, which trend to the east and west, with varying dips. The veins are from a few inches to 6 feet in width, while in places there are numerous parallel veins and stringers in an area of 50 feet to 300 feet wide. Some of the veins can be traced on the surface for a distance 100 to 350 feet. The area containing the fluorspar is well defined, being two miles in length and about one mile in width. The color of the spar is green, white and purple. It is said that the grade mined in sample lots carried from 80% to 85% calcium fluorite with silica content of 4.27%.

The most extensive occurrence of fluorspar was noted on what is known as Fluorite Hill group of claims, where a number of open cuts and shallow shafts expose veins of spar, with widths of 2″ to 2 feet wide, the mineralized zone at this point being 600 feet in width and 1500 feet in length. The most extensive showing of fluorspar is, however, on the eastern end of the mineralized zone, showing outcrops from 3 to 5 feet in width. These veins strike NE. and SW. and dip 60 degrees to southeast. Spar could be hauled to Baxter, a station on the Salt Lake Railroad, a distance of six miles. Six men are employed on development. Owners, Massen and Seropian Metals and Minerals Company, J. M. Seropian, president; J. H. Massen, secretary; 26 Montgomery street, San Francisco, California.

Philadelphia Fluorspar Deposit. It is situated 25 miles south of Cima, a station on the Salt Lake Railroad, in the Providence Range of mountains. The fluorspar occurs in lenses of 10″ to 2 feet in width. Deposit is developed by short tunnel. Fluorspar reported to analyze 74% Ca Fe_2 and 3% S_1 O_2. Owner, C. Roberts and H. N. Benson of Los Angeles, California.

The occurrence of fluorspar is also reported south of Baxter Station, and James Garrity of Baxter, California, has taken up six claims on the deposit. The color of the spar is green, white and purple. It is reported that the fluorspar has a low silica and lime content.

FULLERS EARTH.

(See Bulletin 38, p. 275, Fifteenth Report, p. 863.)

GEMS.

Deposits of chalcedony, bloodstone, and jasper, opals, lazulite and turquois occur in several localities on the Mojave Desert in the northeastern part of the county. (See Bull. 37, pp. 76, 77, U. S. G. S. Min. Resources, 1911. Report XV, pp. 863 to 868.)

GOLD.

Gold was first discovered in San Bernardino Range of mountains in the placers of Holcomb and Bear Valley, in May, 1860. About the same time, gold was found in the placers of Lytle Creek.

In this county there are two chief groups of auriferous veins: Those of the San Bernardino Range, and those of the desert ranges.

The veins of San Bernardino Range occur mainly on and near the north slope of these mountains and close to the margin of the Mojave Desert. The chief districts are: Bear Valley, Black Hawk, Holcomb Valley and Morongo districts.

The chief districts of the desert veins are: Arrowhead, Dale, Goldstone, Gold Reef, Ivanpah, Ord, Oro Grande, Steadman, Twenty-nine Palms, and Vanderbilt. The only placer ground recently worked on the desert is that north of Barstow by the Cool-Gardie Mining Company.

The only new district that has been opened up since the Fifteenth Report of the State Mineralogist was issued is the Gold Reef district, situated 5 miles northwest of Danby, a station on the Santa Fe Railroad, on the southeast slope of Clipper Mountains. District was discovered in 1915. The veins in this district are well defined and are of the quartz-calcite type. They occur in tertiary volcanic rocks. The stronger veins strike northwest. Many dikes cut the formation, most of which strike northwest. These dikes are vertical components of lava sheets, which successively cover a large part of the district. The strongest veins cut the lava series, but some of the dikes are also fissured and carry vein matter. The rocks range in composition from dark basic to light acid phases. Rhyolite and basalt are the newest in the series, andesite and dacite representing the older members. Volcanic tuffs and breccia are dispersed through the general aggregate. Geologic observations would indicate that the veins were formed from 1500 to 2500 feet beneath the surface by hot solutions rising along deep farctures and depositing their minerals en route. Important quartz bodies were thus formed. The uppermost portion of these now shows as a chain of bold outcrops extending for several miles along the main line of fracture. The main quartz calcite vein reaches a width of fifty feet and stands in relief 100 feet above the surrounding country. It is continuous for a distance of 1500 feet. Along this main reef various large outcrops of quartz occur for a distance of 4 miles. The Tom Reed Gold Mines Company of Oatman, Arizona, and the Clipper Mountain Gold Mining Company of Los Angeles have sunk shafts on the main reef to depths of 500 feet to develop and explore the veins at this depth. In both these shafts a strong flow of water was encountered, causing the suspension of operations until pumps could be installed. The Gold Reef Consolidated Mines Company has recently been formed and active development campaign is planned by the company, who plan to use the Clipper Mountain shaft as the main working shaft.

At present writing there is practically no activity in gold mining throughout the county, for in general it costs more to produce an ounce of gold, under current conditions of labor and cost of materials, than the metal itself will bring in the open market. Therefore only those properties that have been operated since the Fifteenth Report of the State Mineralogist was issued will be discussed.

For information on the different gold mines throughout the county see Report XV, pp. 792 to 817.

Anaconda Mine. It is situated in the Twenty-nine Palms district, about 55 miles northeast of Banning. Elevation 2850 feet. Holdings consist of six claims. Vein occurs in the granite, strikes N. 40° W., dip

73 E°. Developments consist of two shafts 100 feet and 185 feet deep. The main working shaft is 185 feet deep, was sunk on a vein having a width of 8″ to 18″. Levels have been driven on the vein at 50′, 100′, 150′ and 185′. The mine is reported to have produced some rich ore above the 100′ level. It is reported that ore milled from these workings assayed $25 to $30 per ton; with a loss in the tailings of $8. Total production from the mine is reported to be $10,000. Idle. Owners, J. P. Rasmussen and Harry Thompson, of Los Angeles, California.

Clipper Mountain Mine. It is situated in the Gold Reef district, on the southeast slope of Clipper Mountain, about 5 miles northwest of Danby. Eight claims were taken up along the main reef. Ore occurs as quartz-calcite veins, having a rhyolite footwall and andesite hanging wall. Vein is from 10 to 80 feet wide, strikes NW. and SE., dip 60° SW. Shaft sunk to vertical depth of 300 feet. It was proposed to sink the shaft to a depth of 500 feet at which depth the footwall of the reef would be cut. At depth of 300 feet, a heavy flow of water was encountered, causing suspension of operations.

Equipment, 30-h.p. Fairbanks-Morse gasoline hoist, Gardner-Rix duplex 6″ x 8″ compressor. Owner, Clipper Mountain Gold Mniing Company, B. G. Doak, president; A. H. Hayes, secretary; P. B. Kepner, superintendent. Offices, 600 I. W. Hellman Building, Los Angeles, California.

Note—Property recently taken over by Gold Reef Consolidated Mining Company; S. S. Wold, president; E. S. Howard, secretary; 600 I. W. Hellman Building, Los Angeles, California, this company consolidating interests of the Gold Reef, Clipper Mountain, and Gold Reef, Tom Reed mines, and operating as one property.

Contact Mine. It is 55 miles northeast of Banning, in the Twenty-nine Palms district. Vein of quartz occurs in mica schist near granite contact. Vein strikes N. 40° E., dip 60° W. General trend of the schist is N. 10° E. Workings consist of 150 foot shaft, sunk on the vein, and an open cut along the outcrop for a distance of 50 feet north of shaft. On 50 foot level there is a drift 25 feet south on the vein. The vein averages about 2 feet in width. The vein quartz contains occasional bunches of galena, and a small percentage of iron pyrite. The ore milled from the property is reported to have yielded $70 per ton by amalgamation, and concentrates carried $260 per ton. Idle. Owner, P. T. Sullivan of Twenty-nine Palms, California.

Desert Gold Placer Mine. Ivanpah district. Desert Gold Dredging Company, H. P. Ewell, president, George W. Cram, secretary; offices, 415-416 Union Oil Building, Los Angeles; have located 115 placer claims on Desert Lake, 6 miles east of Ivanpah and 10 miles south of Roach, Nevada. Gold is stated to occur in unconsolidated sands and gravel of dry lake bed, known as Desert Lake. It has been reported that pay gravel has been proven to depth of 3 to 6 feet by test holes. Stated the gravel will average 20 cents per cu. yd. It was planned to install a dredge on the lake, but the European war interfered, and the plans of the company did not materialize.

Gold Reef Mine. Situated in Gold Reef district on the southeast slope of Clipper Mountain, 5 miles northwest of Danby. Elevation 2600 feet. Ore occurs in highly siliceous dike, striking northwest and southeast with dip of 60 degrees SW. Developments consist of vertical shaft 100 feet deep, also a number of shallow prospect shafts and open cuts on quartz-calcite veins along the outcrop of main reef. Property being operated by Gold Reef Consolidated Mines Company, offices 600 I. W. Hellman Building, Los Angeles. Owner, Gold Reef Mining Company; W. P. Reynolds, president; Frank Siever, secretary; P. B. Kepner, superintendent, 826 Washington Building, Los Angeles, California.

Gold Reef (Tom Reed Mines). The mine is in the Gold Reef district, 6 miles northwest of Danby. Elevation 2700 feet. The quartz calcite-vein on Gold Reef No. 6 claim reaches a width of fifty feet, and stands in relief 100 feet above the surrounding country. It is continuous for a distance of 1400 feet. On No. 6 claim a vertical shaft has been sunk to a depth of 500 feet in the hanging wall about 250 feet west of the vein. At the 500 foot level it is proposed to drive a crosscut to vein and drift along the vein and connect with workings of the Clipper Mountain Mine.

Recently large pumps were installed by the Gold Reef Consolidated Mines Company at the Clipper Mountain shaft, and pumping operations drained the water from the Tom Reed Company's shaft. The development work was started from this shaft, and the company hopes to develop a large tonnage of ore that will average around $6 per ton in gold.

Owner, Tom Reed Gold Mining Company, Oatman, Arizona. Operated by Gold Reef Consolidated Mines Company; offices, 600 I. W. Hellman Building, Los Angeles.

Gold Mountain Mine. This mine is situated in San Bernardino Range of mountains, north of Baldwin Lake in Bear Valley mining district. Elevation 7350 feet. Operated from 1860 to 1900 by Lucky Baldwin, and from 1900 to 1908 by Capt. J. R. DeLamar. Reopened in February, 1918, and operated until November 1, 1919, by James Hulmes of Berkeley, California. There are 16 claims along the lode. The vein system occurs as irregular bodies of massive quartz containing free gold, have been formed as a replacement of quartzite along its contact with schist. The quartzite is greatly shattered, and numerous seams cut the quartz. The values are mostly found near the cross fractures. The strike of the ore body is N. 60° W., dip 60 to 70 degrees south. The dip, however, flattens with depth. In the main adit tunnel, being only 30° south, the average width is 40 feet. Occasional masses of crushed quartzite are inclosed in the quartz. These have to be sorted out as the gold rarely occurs in the quartzite. Developments consist of a glory hole approximately 600 feet long by 40 feet wide by about 50 feet deep. An adit tunnel 700 feet long was driven N. 60° W., 85 feet vertically below outcrop. This is connected with bottom of glory hole by means of chutes. All ore is mined from this glory hole. Ore is said to average $4 per ton throughout, now working richer portions running from $6 to $10 per ton. Equipment, 9″ x 10″ Gardner compressor, and air drills. Mill, two No. 3 Gates gyratory

crushers; thirty-five 1000-lb. stamps; plant operated by 150-h.p. steam engine. Nine men employed. Owner, James Hulmes, Pine Knot, Bear Valley, California.

Gold Park Consolidated Group of Mines. W. C. Winnie, president; J. E. Schweng, secretary; C. W. Roach, manager; offices, 1021 Black Building, Los Angeles, California. This company owns a group of 52 claims in the Twenty-nine Palms District, 64 miles northeast of Banning, and 4 miles south of Twenty-nine Palms. Some of the holdings are in San Bernardino County, while others are just south of the line in Riverside County. The following groups have been developed to some extent: Atlanta, Black Warrior, Boss, Caladonia, Gold Park No. 1, No. 2, and No. 27 and Oro Copio.

Gold Park Group No. 2.

Elevation 2300 feet. This group consists of ten claims. The ore occurs in lenses of quartz at intervals along fractures in a coarse grained granite. The general trend of these veins is N. 10° W. Near the surface the dip is steeply to the east, with depth changing slightly westward. The veins are usually narrow, about 8″ to 18″ of quartz, but occasionally widening to 6 feet. The gold is free milling and very finely disseminated. Seldom visible to the naked eye. Copper stains occasionally occur in the quartz, but these disappear usually below 20 foot depth. The workings on this group are mostly superficial, consisting of shallow shafts and trenches. The pay shoots are short, consisting of a maximum length of 60 feet. Said to average $8 to $10 per ton in gold. Developments consist of tunnel 100 feet long, and a number of shafts from 30 to 50 feet deep. Mill, 2 Nissen stamps and Bryan roller mill at Twenty-nine Palms. At mine there is one stamp test mill driven by 5-h.p. gas engine.

Boss Mine. A shaft has been sunk to a vertical depth of 122 feet on the vein, and a few feet north of intersection of the main vein striking due N. and S. and a branch striking about S. 10° W. These veins are in the granite. On the 65-foot level the vein was drifted on to the south connecting with a 100-foot shaft. The vein on this level shows a width of 1½ to 2 feet, and was stoped to the surface. At the bottom of shaft a drift was run due north 200 feet, but no pay shoot encountered. There are at least 1000 feet of crosscuts and drifts on this level. The vein formation is about 4′ wide, showing 8″ of quartz, the remainder consisting of shattered granite and stringers of quartz. Equipment, 7-h.p. gas engine hoist. Owner, Gold Park Consolidated Mines Company.

Atlanta Mine. On this claim a narrow vein of quartz occurs in the granite, striking N. 10° E. and dipping almost vertical. The workings consist of shaft and three tunnels of different elevations. The shaft is located near foot of hill and to the south of the tunnels, and was sunk to depth of 100 ft. on a narrow vein. About 100 ft. above the collar of this shaft is the lower tunnel. This was driven N. 10° E. for about 250 ft., about 150 feet from portal raise to upper tunnel and surface. Beyond this raise the tunnel is caved, so was not accessible. Practically no ore is exposed in lower tunnel. Fifty feet above tunnel is the Intermediate tunnel, driven on seam in granite, which opens

into a narrow lens of quartz. The shoots of ore developed in these workings were short, but reported to carry high values in gold. Owner, Gold Park Consolidated Mines Company.

Caladonia Mine. Workings on this claim consist of two shafts, sunk on vein to depth of 50 and 100 feet. Vein varies from 2½ to 4 feet. The ore extracted from these workings was treated in one stamp mill and reported to have yielded $12 per ton on the plates. The quartz lies between rhyolite and granite footwall. Owner, Gold Park Consolidated Mines Company.

Black Warrior Mine. This is the most southernly mine of the group, lying about 3½ miles south of camp. The mineralization occurs along a shear zone in altered granite. The hanging is a gneiss with a well defined talc wall. General trend of the ore body is N. 10° W. with a dip to the west. Workings consist of a 200-foot shaft sunk on the vein in the center of claim. The quartz in the vein matter is highly oxidized and contains considerable iron and lime. Its black appearance, due to iron and manganese stains, gives it its name. The vein is different from the others of the district, containing considerable pyrite and some arsenopyrite. The dump is said to contain 2200 tons of ore which will assay $14 per ton. The shaft is vertical to 70-foot level, from this point sunk on an incline of 65 degrees east. On 70-foot level a drift run 100 feet N. 45° W., exposing an ore body 60 feet in width. Mineralized zone made up of quartz and brecciated wall rock. On 150′ level a crosscut was run for 60 feet west, and is said to be entirely in ore. Equipment, 12-h.p. gas engine hoist; 8″ x 8″ compressor. Two men employed on development work. Owner, Gold Park Consolidated Mines Company.

Oro Copio Mine. On this claim the mineralization follows a shear zone, and the granite has been altered to a gneiss. A shaft sunk on vein to depth of 50 feet. Vein strikes N. 10° E. About 150 feet south of this shaft another shaft has been sunk on narrow quartz vein to depth of 100 feet. Vein 2 feet wide, stated average $8 per ton. Owner, Gold Park Consolidated Mines Company.

Hidden Hill Mine. Arrow district. It is situated 20 miles north of Fenner, a station on the Santa Fe Railway, on the eastern slope of the Providence Range of mountains. Claims: Hidden Hill, Bill McKinley, Golden Queen, Golden Queen Fraction. A series of parallel veins occur in a porphyritic granite, which is highly brecciated along these fractures. The veins are narrow, varying in width from 1″ to 12″. The quartz contains jasper with high gold values, and small amount of chalcopyrite. Veins strike N. 30° E. and dip 45 degrees west. The veins are displaced by a number of north and south faults.

Developments consist of incline shaft 240 feet deep. Crosscut tunnel 350 feet long. The shaft and main workings are located on the Golden Queen claim. Other claims have been developed by shafts from 50 to 100 feet deep. Mine was noted for high grade ore, only ore assaying around $50 was shipped. During 1913 one pocket encountered produced $13,000 from 300 lbs. of rock. Idle. Claypole and Company of Needles, California, owner.

Holcomb Valley. (Placer.) Lee Du Bois is testing the Holcomb Valley placer ground with a Keystone drill for the purpose of determining whether the gravels will pay to dredge. The gold placer ground of Holcomb Valley has been worked at intervals since 1860, but main difficulty of working the gravels is a heavy underground flow water encountered in shafts sunk, making it impossible to reach bedrock. It is feasible to work the placer ground by means of gold dredge, and if Mr. Du Bois' tests prove successful, it will mean a revival of mining activity in the district.

Bibl.: Rept. XV, pp. 798–799.

Mabel, Contention and Investment Group of Mines. This group of mines are in the Arrow mining district, 23 miles northwest of Fenner, at an elevation of 3750 feet, on the eastern slope of the Providence Range of mountains. There are 12 claims in the group.

The geology of the district. The formation is composed of principally granite, diorite, quartzite and porphyry. The lateral pressure that folded and faulted the country had no doubt much to do with the mineralization of this section, making many fissures which offered free passage to mineral solutions. At the time of this disturbance the country was intruded by the great porphyry dike, along which the mineral has been deposited in fissures and contact veins of various widths, strikes and dips. The intrusions have been very much altered. Some secondary movement has occurred along the contacts, which has altered the porphyry and granite walls, and caused the talc gouge now seen in the veins. The veins vary in thickness from few inches to 4 feet. The dikes of intrusive nature are over a hundrd feet in width and stand up prominently above the surrounding country; having been highly silicified, ore occurs on both walls of these dikes. The dikes have a general north and south trend and are faulted on a number of places on the property. Veins have a N. 20° E. strike, and dip 40° to 75° W. There are also a number which have an east and west strike and dip south, the most notable being the Contention and Big Ledge veins; the latter is 10 to 12 feet wide. The ores are siliceous in character, and contain values in gold, silver and copper, the principal value being gold.

Developments, Contention shaft 200 feet deep, with levels driven on the vein at 65′, 100′, 144′ and 200′. On 200′ level the vein has been drifted on 125 feet east and 115 feet west. Ore developed in this mine is reported to carry from $6 to $8 per ton in gold. Subway shaft is 50 feet deep, with a level driven 200′ north on vein. Mabel shaft 140 feet deep, with drifts on the vein. A large number of proposed shafts have been sunk on the different claims, all developing some ore.

Equipment consists of 3-stamp mill, one Standard concentrator and 10-h.p. gas engine. Property was under operation during the latter part of 1918 and the early part of 1919. Production is stated to have been about $100,000, all of which was shipped to the smelters. Only ore exceeding $50 per ton was shipped. Idle. Thomas A. Gannon, Fenner, California, owner.

North Star and Big Blue Mines. These properties are in the Big Bear Valley mining district, 45 miles east of Victorville. Vein 2 feet wide occurs on contact of limestone and mica schist. Strike east and west. Dip 45 degrees north. Mine adjoins the Rose mine. Developments consist of 300-foot tunnel driven on vein. Equipment consists of compressor, air drills and blacksmith shop. Property under option to Talmadge Bros. of Victorville. Owner, Al. Watts of Victorville, California.

Olympus Gold Mine. Situated on south slope of Paradise Range of mountains, at an elevation of 2300 feet, 22 miles north of Daggett. Holdings consist of 7 claims. Series of parallel veins occur in granite. Strike N. 30° W. Dip 33° NE. Varying width from 6 to 20 feet. The principal developments have been on the Klondike vein. Incline shaft has been sunk to a depth of 400 feet on the vein. At the elevation of the shaft, a tunnel has been driven north 400 feet on the vein. The vein in this tunnel has an average width of 6 feet of quartz, and in places lenses out to 20 feet. Fifty feet vertically above this tunnel there is a tunnel driven 300 feet on the vein, this upper tunnel being connected with lower tunnel by series of raises. At 365 feet from portal of lower tunnel the vein was cut off by a fault which strikes N. 45° E. It is reported that 50,000 tons of ore have been developed above the lower tunnel which will average $6 per ton in gold. Only small amount of drifting has been done on the vein from levels in the shaft, about 50 feet north and south on 135-foot level, 50 feet south on the 235-foot level. The mine is supplied with water from Paradise Springs, a distance of 2½ miles.

Equipment consists of 25-h.p. gasoline hoist, 9″ x 8″ Ingersoll-Rand compressor; 10-stamp mill driven by 40-h.p. gas engine and one Gibson mill. Three men employed in driving a lower tunnel to connect with incline shaft at a depth of 400 feet. Owner, Olympus Gold Mining Company; S. E. Bagley, president; M. W. H. Williams, secretary; H. Galerone, superintendent. Offices, 508 Alvarado street, Redlands, California.

Rex and Valencia Hill Group of Mines. Situated in Holcomb Valley district, 42 miles east of Victorville. Elevation 7500 feet. General formation is granite, through which intrude large deposits of quartzite, and irregular masses of quartz occur throughout the quartzite. On the Rex claim the quartzite is well defined, outcrops boldly for 1000 feet, having average width of 250 feet. This deposit can be traced through the adjoining claim to southeast. A shaft has been sunk near center of claim on an incline of 65 degrees to SW. to depth of 100 ft. The shaft was sunk in a cross-break in the main outcrop of quartzite, which break was filled with an intrusion of schist. A number of shallow shafts and open cuts have been made along outcrop on masses of quartz in the quartzite, from which values in gold assaying from $5 to $8 per ton have been obtained. The ore occurrence on these claims is very similar to the Gold Mountain mine, which is located east of these claims. Idle. Owner, Rex Mining Company; R. H. Gilman, president; C. L. Metzger, secretary; 1682 W. Twentieth street, Los Angeles, California.

Total Wreck Mine. It is 3 miles northwest of Yermo, on the south slope of Gold Mountain, in Calico mining district. Elevation 2300 feet. The vein occurs as an iron-stained brecciated quartz along a fault fissure on contact of sandstone and tufacious breccia. Strike NW. and SE. Dip 70 degrees south. Width 8″ to 3 feet.

Developments consist of crosscut tunnel 500 feet long. In crosscut tunnel at 125 feet from portal cut what is termed the lead vein, and the vein is drifted on 60 feet to southeast. On SE. side of tunnel a winze was sunk to a vertical depth of 80 feet, cutting through the vein, which dips south. The crosscut tunnel continues in a northerly direction for about 270 feet, where cut the contact of the stratified sandstone and massive breccia, cutting a small vein of gold-bearing rock, which was drifted on 50 feet to the west. At 35 feet farther on cut a larger fissure, which was drifted on 600 feet to northwest. Reported ore in this drift will average about $8 per ton in gold. This contact vein is not parallel with the lead vein, but going easterly towards it, and the indications are that the two fissures will unite about 600 feet east of crosscut tunnel. The occurrence of the gold in the vein material is very fine. Owner, Mrs. Rosella Burcham, Randsburg, California.

GRAPHITE.

A deposit of graphite is said to occur near head of Santa Ana River in the San Bernardino Mountains, about 15 miles from East Highlands, a station on Santa Fe Railroad. It is undeveloped. Owner, W. E. Van Slyke, 716 Fifth street, San Bernardino.

Bibl.: Bull. 38, p. 280.

Eva Cañon Graphite Deposit. The deposits are in Eva Cañon, north of Ontario, about ½ to 1 mile from the mouth of the cañon, in an area of crystalline schists and associated with granite pegmatite. At the graphite prospect the schists are much decomposed, and in places there has been much slipping parallel to their foliation. The greatest width of highly graphitic material is about 5 feet. The graphite is crystalline but very fine grained, and so intimately mixed with silicates that it could probably not be separated from them economically in deposits so small.

(Notes taken U. S. G. S. Bull. Graphite by E. S. Bastin.)

GYPSUM.

San Bernardino County contains gypsum deposits in many places on the desert, the most notable and at present the only one being worked being that of the Consolidated Pacific Cement Plaster Company in the Amboy Sink. A similar deposit is said to exist at Danby Dry Lake, 32 miles southeast of Danby Station, on the Santa Fe Railway.

Gypsum occurs also in thin-bedded deposits associated with the beds of rock salt in the Avawatz Mountains, and to a lesser extent in the borax beds of the Calico district. A deposit was located some years ago near Camp Cady on the Salt Lake route.

Bibl.: Bull. 38, p. 287. U. S. G. S. Bull. 413, pp. 25-28.

Amboy Dry Lake Deposits. Consolidated Pacific Cement Plaster Company; office, 612 San Fernando Building, Los Angeles, California; J. D. Bowerstock, president; D. A. Mulvane, secretary. This company is operating on the west side of Amboy Dry Lake, and has a mill at Amboy.

Bibl.: XV Rept., pp. 868-870. U. S. G. S. Bull. 697, pp. 81-82.

Avawatz Mountains Deposits.[1] Not far from the northern boundary of San Bernardino County, on the northeast edge of the Avawatz Mountains, there are extensive deposits of rock gypsum. The locality is at the extreme south end of Death Valley, and about 10 miles west of the Tonopah and Tidewater Railroad. The Avawatz Salt and Gypsum Company of Los Angeles has gypsum claims in sections 15, 22, 23, 25, and 26, T. 18 N., R. 5 E., San Bernardino base and meridian.

The gypsum-bearing strata range from 150 to about 400 feet thick, the average thickness being about 250 feet. They outcrop over an area 9 miles long by 1 mile wide. These strata consist of greenish or reddish sands and clays, which carry large quantities of gypsum, and beds of rock gypsum 1 to 10 feet thick. The rock gypsum is massive, fine grained and varies in color from white through shades of green, pink and red to dull black. Analyses of a number of samples show from 74 to 97 pure gypsum.

M. Mulcahy et al., of Daggett, have two gypsum claims in Calico district, 2½ miles west of Yermo on Salt Lake Railroad. The gypsum occurs in beds varying from 2′ to 4′ in width, associated with the borax beds in the Tertiary sediments of the Calico range. Idle.

Bibl.: Rept. XV, p. 870.

IRON.

Large deposits of iron ore occur in the desert regions of San Bernardino County. It is estimated that there are 20,000,000 tons of available high-grade ore, and double that amount of probable ore in Riverside and San Bernardino counties. The principal deposits in San Bernardino County are: Cave Cañon Group, north of Baxter; Iron Age, 6 miles east of Dale; Iron Mountain Group, 10 miles west of Silver Lake; the Vulcan Group in Providence Range of mountains, 4 miles east of Kelso, and the Armstrong and Doran Group, 8 miles northwest of Cadiz. Less important deposits occur in the Keystone Mountains, north of Amboy, south of Blythe Junction, and in the Lava Beds district south of Daggett.

The iron ore deposits of San Bernardino County will eventually become of importance both on account of exhaustion of high-grade ores in the eastern section of the country and because of the necessity for supplying the growing demands of the Pacific Coast.

For detailed description of the different deposits see Bulletin No. 38, p. 299; U. S. G. S. Bulletin No. 285, p. 198; U. S. G. S. Bulletin No. 430, pp. 228-239; Bulletin of A. I. M. E., September, 1915, 1889; Report IX, p. 235; Report XV, pp. 817-821.

[1] Abstract from report made by H. R. Johnson for the Avawatz Salt and Gypsum Company.

LIME AND LIMESTONE.

Limestone deposits of great commercial value occur in several localities in San Bernardino County, the most important ones being those at Baxter, Colton and Oro Grande.

Bibl.: Bull. 38, pp. 61-64. Fifteenth Report, pp. 871-879.

LIMESTONE.

Swarthout Cañon Limestone Deposit. McFadden Corporation, 434 Marsh-Strong Building, Los Angeles, California; Ward McFadden, president; S. W. Crockett, superintendent, are opening up a large deposit of limestone in Swarthout Cañon, 10 miles northwest of Cajon, a station on the Santa Fe Railroad. The limestone is hard and coarsely crystalline and mostly white in color, said to be very pure. Company plans to ship a large tonnage to Los Angeles and other cities on the coast. Twelve men are employed.

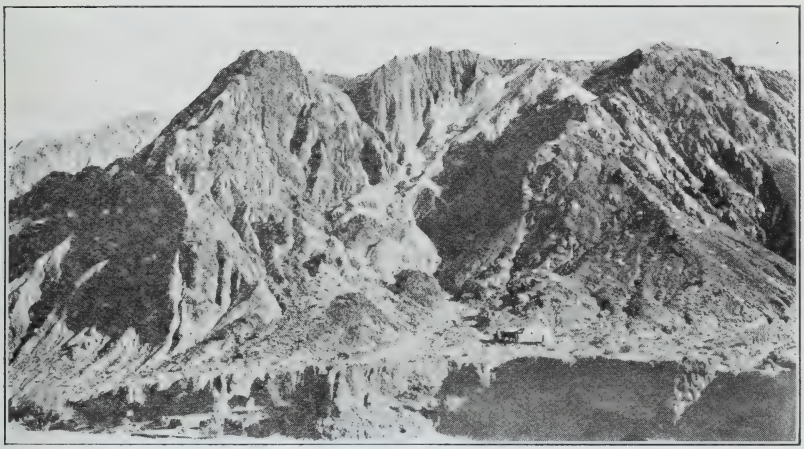


Photo No. 42. Afton Magnesite Mine, Afton, San Bernardino County; Cliffside Magnesite Company, San Bernardino, California. Photo by Dr. Cook.

MAGNESITE.

Afton Magnesite Mine. Situated 1½ miles east of Afton Station, on the Salt Lake Route and less than 2000 feet south of the railroad. The deposit is located on steep hillside on the east side of Cave Cañon.

Three claims, Cliffside, Hill Top and Crown, have been located along the outcrop. The deposit of magnesite outcrops as a bold white ledge striking easterly over a precipitous ridge which rises abruptly out of the Mojave River Valley to an elevation of 500 feet above the floor of the valley. The magnesite ledge is exposed for about 400 feet from the base to the top of the croppings. It forms a striking landmark visible several miles west of the deposit. Near the top of the cropping a slide has denuded it for a width of a couple of hundred feet. It here appears to be about 10 to 20 feet thick, dipping 40 degrees northward. There are at least a thousand tons exposed in this place; undoubtedly a large tonnage can be developed.

The magnesite occurs occasionally as nodules. This condition is near the hanging wall. Nearer the footwall it is harder and stratified, varying from massive to thin, platy structure; occasional seams of silica occur interbedded in the magnesite. Its color varies from pinkish to dead white. The magnesite underlies a soft red colored decomposed conglomerate material. This in turn underlies a hard, fine-grained gray sandstone, whose trend is parallel to that of the magnesite. Underlying the magnesite are decomposed sandstone and dark, bluish, slaty shales.

Analysis of magnesite: (Smith, Emery and Company.)

$Si\ O_2$	10.10%	Ca O	3.10%
$Al_2\ O_3$	1.73%	Mg O	38.19%
$Fe_2\ O_3$	1.41%	CO_2	40.65%

An aerial tramway has been installed from mine to bins at siding on railroad. A calcining plant is being installed in San Bernardino. Six men are employed. Owner, Cliffside Magnesite Company, John M. Nordheim, president; W. J. Swan, secretary, San Bernardino, California.

MANGANESE.

Very few deposits of manganese of any commercial importance are known in San Bernardino County. However, some deposits of promise were developed during 1915 and 1916, the most important being the Owl Hole Manganese Mine, 36 miles west of Riggs Station, on the Tonopah and Tidewater Railroad.

Numerous low-grade deposits occur in the desert region, but in general the percentage of silica contained is too high to make them of commercial value.

Emma Group of Manganese Claims. The deposit is located 36 miles west of Riggs, a station on the Tonopah and Tidewater Railroad, about 1 mile north of the Owls Hole mine. At an elevation of 2800 feet, on ridge north of Owls Hole mine, a vein of manganese occurs on contact of granite and limestone. The outcrop can be traced along the contact for several hundred feet. Manganese occurs as pyrolusite, and shows a low silica content. Developments consist of series of short tunnels. Idle. Ruben Stinton of Silver Lake, California, owner.

Black Stone Manganese Deposit. It is 3 miles southeast of Afton, a station on the Salt Lake Railroad, on ridge east of the Mojave River. Elevation 2600 feet. A series of lenses of manganese occur on contact of granite and limestone, for distance of about 1000 feet. The strike of the contact is north and south, with a dip of 70 degrees to the east. The largest lens noted was about 50 feet in length and 8 to 10 feet wide. The fracture can be traced for a mile, and at intervals shows from 8 inches to 4 feet of ore. Manganese occurs in form of psilomelane, with small amount of pyrolusite. Idle. Owner, J. H. Massen of Yermo, California.

Lavic Mountain Deposits. These deposits are situated 5 miles northwest of Ludlow in the Lavic Mountains. Manganese oxides occur

along a series of parallel fractures in a rhyolite breccia. The outcrops can be traced for a distance of one mile. The veins strike N. 60° W. with dip of 60° southwest. The veins have widths 12 inches to 3 feet. Ore is psilomelane. Developments consist of series of open cuts on different veins. In 1917, 100 tons of ore were shipped from the property. Ore carries high silica content. Idle. Owners, Seymour Al. I. D. Garinger, and L. N. Root of Daggett, California.

McDowell Group of Manganese Claims. The claims are located on low-lying hills west of Colorado River, about 20 miles north of Parker, Arizona.

Manganese oxides occur in several places on the claims in small seams and in deposits formed by impregnation from fissures, but rarely do the deposits of manganese oxides attain a width of 3 inches and they persist for only a few feet. Small veins of psilomelane that strike east and west were noted in diorite and granite near the river. Psilomelane is the dominant oxide in these deposits, but some pyrolusite was also observed. Calcite occurs in the seams with the manganese oxides. Only a prospect; seas of ore are too small to be mined. Idle. H. W. McDowell, Arizona.[1]

Owls Hole Manganese Mine. It is situated 36 miles west of Riggs, a station on Tonopah and Tidewater Railroad, northwest of Owl Hole Spring, Owl Mountains and southwest of Death Valley narrows. Elevation 2400 feet. The manganese oxides occur along a series of fault fractures which strike NW. and SE. in granite, and also on contact between the granite and limestone, the latter at one time covering the whole area of the granite, but has since been mostly eroded. At different points the granite is overlain by granitic conglomerate. Two shafts have been sunk to depth of 60 feet along these fractures, which are more or less parallel. The ore developed in these workings shows a width of 4 to 6 feet. There is also an open cut 150 feet in length on a parallel vein about 50 feet west of north shaft, showing 3 feet of ore in south face of cut. North of shaft in gulch there is an open cut where the manganese oxides occur on contact of limestone and a granitic conglomerate. The croppings at this point are 50 feet wide, and the ore is intermixed with the granitic conglomerate. At the edge of this cut a shaft is sunk 50 feet in ore. About 1½ miles north of these workings there is a large body of manganiferous iron croppings 200 to 300 feet long and about 50 to 75 feet wide. Developed by series of open cuts. Manganese oxides are psilomelane, pyrolusite, and manganite. Calcite occurs in the fractures with the manganese oxides. Ore shipped from the property is stated to have carried 45% to 70% Mn O_2. Ore was hauled by tractor and trucks to Riggs Station. Idle. Owner, Alex Yoeman of Silver Lake, California.

Red Cross and Hidden Treasure Groups of Manganese Claims.[2] These claims are located 11 miles north of Drennan, a station on Parker Branch of Santa Fe Railroad, in the Whipple Mountains. Elevation 2300 feet.

Manganese ore occurs as lenticular and irregular masses in the sandstone, limestone and volcanic breccia. Some of the ore bodies are

[1] Extracts taken from U. S. G. S. Bull. 710-E.
[2] Notes from U. S. G. S. Bull. 710-E.

connected with northwesterly fissures along bedding planes. There are many outcrops of ore on the claims, but only a few have been exploited. One deposit enclosed in volcanic breccia is 25 feet long and 4 feet wide. At two other places ore occurs in fissures in the limestone. Bodies being 8 feet wide and 25 feet long. Manganese ore consists of massive psilomelane with a small amount of pyrolusite present. The ore is high grade, shipments of ore stated to have yielded 45% manganese, 4% silica, 2% iron, and 0.04% of phosphorus. Idle. Owners, Fred W. Hall and Mrs. Maude Washbesh of Parker, Arizona.

MARBLE.

Nearly all the limestone found in San Bernardino County may be classified as marble, but none is being quarried for building or monumental purposes. For detailed description on these deposits see our Bulletin No. 38, pp. 102-148, Report XV, pp. 879-883.

MINERAL WATER.

For detailed description of Mineral Springs of San Bernardino County, see U. S. G. S. Water Supply Paper 338, by Gerald Waring; also Report XV, pp. 883-891.

MOLYBDENUM.

Small kidney like deposits of molybdenite occur in a granitic gneiss, on ridge west of the south fork of Lytle Creek, 2 miles west of Glen Ranch and about 3 miles west of Keenbrook Station on Santa Fe Railroad.

The occurrence of molybdenum is also reported near Bonita Falls on south fork of Lytle Creek.

NITER.

(See Bulletin 24, pp. 174-178, Report XV, pp. 890-891.)

QUICKSILVER.

The occurrence of quicksilver is reported 9 miles northeast of Danby Station on Santa Fe Railroad. Fourteen claims have been taken up on the deposit by F. T. Madden and associates.

It is stated veins of quartz from 4 to 6 feet wide occur in serpentine which is impregnated with cinnabar.

SALINES.

Salts.

There are inexhaustible deposits of salt widely distributed over the desert portion of San Bernardino County, many of which have not been developed. Several companies are now producing limited amounts and there is an excellent outlook for increased production in the near future.

Avawatz Salt and Gypsum Company, Kerckhoff Building, Los Angeles, California; H. H. Kerckhoff, president; Thos. L. Henderson, secretary. The company owns 52 claims, containing about 5200 acres, along the northeast margin of the Avawatz Mountains, 10 miles west

of Tonopah and Tidewater Railway. Extensive beds of rock salt occur on the company's holdings, said to be 95% pure, sodium chloride. Idle.

Bibl.: Bull. 24, pp. 126-128. U. S. G. S. Bull. 540, pp. 526-530.

Consumers Salt Company, 304 Grant Building, Los Angeles; L. E. Stump, president; J. G. Hunter, secretary. This company is working a deposit of rock salt in old lake bed 4 miles south of Saltus, a siding on Santa Fe Railroad. The beds of rock salt are 8 feet thick with an overburden of sand and gravel 4 feet thick. In working the overburden is first removed by scrapers, and the salt blasted out with dynamite. A narrow gauge railroad connects the mine with the mill, located at Saltus, 3 miles east of Amboy. The salt treated in mill is first crushed, washed in saturated brine and then dried in a rotary calciner. Mill operated by a 25-h.p. gas engine. Production, when operating, 300 tons per month.

Danby Dry Lake Salt Deposit. A bedded deposit of rock salt stated to be 15 feet thick occurs in Danby Dry Lake, near Ward, a station on Atchison, Topeka and Santa Fe Railroad, on Parker cutoff. Estimated tonnage said to be 25,000,000 tons. Analysis 98% pure sodium-chloride. Holdings consist of 660 acres of patented land. Small production being made from the property. Owners, R. B. Evans of Pasadena, and Judge Russ Avery of Los Angeles, California.

Pacific Rock Salt Company, 600 Central Building, Los Angeles, California, owns a deposit of rock salt in the Amboy sink, a few miles southeast of Amboy. The beds of rock salt are said to be 8 feet thick, overlain by an overburden of sand and gravel about 4 feet thick. A large tonnage has been proven by drilling on the company's holdings. The company has a small mill east of Amboy. For description of other undeveloped salt deposits of San Bernardino County see our Bulletin No. 24, "The Saline Deposits of California," pp. 126–133.

SODA AND POTASH.

Searles Lake, for many years an important source of borax, is now the principal source of potash and soda in California. Three plants are extracting potash from the brines of Searles Lake, namely, American Trona Corporation, Solvay Process Company, and West End Company.

The saline deposits of Searles Lake are fully described by Hoyt S. Gale in U. S. G. S. Mineral Resources, 1912, Part I, p. 886. See also Bull. 540, p. 405, and Prof. Pap. 98-A.

American Trona Corporation, Pantages Building, Los Angeles, California; Alfred von der Ropp, president; J. H. Brown, secretary. The plant is situated at Trona, on Searles Lake, 30 miles from Searles, a station on the Nevada and California Railroad.

The crystal lake area consists of 13 square miles, one-third of which is concentrated brine. The average depth of the potassium chloride bearing ground is about 80 feet. The average potash content of this crystal body is roughly 4% K Cl. Charles G. Lee reported that the crystal body contains 110,000 million gallons, or 594,000,000 tons of

brine. This does not include any incoming waters from either underground or surface sources. The potash contained in the brine is estimated to amount to 23,760,000 tons of potassium chloride. Ten wells have been sunk in center of crystal lake area, and the brine is pumped from these wells by two centrifugal pumps, through an insulated 10″ pipe line to two large storage tanks 500,000 gallons capacity each. From storage tanks the brine goes to pre-heaters, then pumped to evaporating pans, consisting of two triple-effect 22-foot diameter Monster vacuum pans, and two double effect 16-foot diameter pans of same design. On top of each pan is a motor which drives an agitator, as it is necessary to keep solution under agitation. The liquor in pans is boiled down to the point where the potassium chloride begins to salt out, and is then sent to the crystallizing house in this condition at temperature of 90 to 95° C. The triple effect pans are operated with constant flow, the liquor entering the pan next to the vacuum pump (where the vacuum is highest and the boiling point the lowest) and passing in constant flow from this pan through the intermediate pan to the final high temperature low-vacuum pan, and from this pan to the crystallizing house. The pans stand 86 feet high and are 22 feet in diameter. The pans handle from 200,000 to 250,000 gals. of raw brine, and about 100,000 gallons of mother liquor per 24 hrs. This total of 300,000 to 350,000 gals. of liquor is concentrated to about 100,000 gals. of "concentrate liquor" before being sent to the crystallizing house to cool. During the boiling, sodium chloride, sodium sulphate and sodium carbonate are salted out. These tailings salts drop to bottom of vacuum pans, and are removed by salt elevators, which handle approximately 350 tons of waste salts per 24 hours. The elevators discharge their salts into waste salt cones from which they are washed back to the lake with brackish water. The concentrated liquor goes to a rapid cooling system where the temperature as low as 10° C. is used, and by which means the two crops of salts are obtained. One crop contains 75 to 80% K. Cl. These salts then pass through filters and centrifugals for drying, and are shipped east to the fertilizer market. The second crop contains 50 to 60% borax and 20% K. Cl. This material goes through a subsequent treatment separating the borax from K. Cl, and furnishes refined borax 99½% purity and high grade K. Cl, running 95%, which goes to chemical trade. The capacity of the plant is about 20,000 tons per year, or approximately 100 tons per day of crude potash. At present the plant is producing 1800 tons of crude potash salts per month, using only one of the two units. The product analyzes from 75 to 80% K. Cl, and contains less than 3½% borax.

Dr. H. W. Morse is technical manager of the corporation.

Power plant contains twelve 500-h.p. Babcock-Wilcox boilers, which supplies steam for evaporation and power for plant.[1]

Solvay Process Company. This company has leased the Pacific Coast Borax Company's ground on Searles Lake, consisting of 1000 acres. The company has erected a plant and refinery at Boro-Solvay. The plant is located 2 miles from the plant of the American Trona Corporation, producing about 200 tons per month of high grade salts.

[1] In above description, free use is made of Mr. Alfred De Ropp, Jr.'s article published in Mining and Oil Bulletin of July, 1919, "Potash of Searles Lake."

West End Company, of Reno, Nevada. Constructing a plant for the extraction of potash from the brines of Searles Lake.

SILVER.

In the year 1881, important discoveries of silver ore were made in the desert regions of San Bernardino County. The most important silver districts were at Calico, Ivanpah, Trojan, and Silver Reef districts. In 1919, due to the discovery of high grade silver in the Rand mining district, near Atolia, on the San Bernardino and Kern County line, a new silver district has been added to the above named. Mining in these districts was active during the eighties and early nineties, and at present writing with high market value of silver there has been increased activity in mining in some of these old districts. By far the largest production of silver in the county was derived from the Calico district.[1]

Alta Mine. It is situated 1¼ miles east of Riggs, a station on the Tonopah and Nevada Railroad, at an elevation of 1800 feet, on the northwest slope of the Shadow Range of mountains. Holdings consist of 11 claims. The ore occurs in irregular lenses along a series of parallel fault fissures which strike north and south, and also at intersections of east and west fissures with the main north and south fractures in the limestone. Ore occurs as native silver, galena and chlorobromides of silver. The main fissures are filled with a porphyritic material which is heavily stained with iron and manganese, and the high grade ore as a rule occurs with barite. Width of veins varies from 12″ to 4 feet. The north fissures dip 65 to 70 degrees west. Developments consist of crosscut tunnel 300 feet in length, driven at an elevation of 1800 feet, on the steep side of mountain above the camp. Most of the ore was taken out above this tunnel, through an intermediate tunnel 50 feet vertically above lower tunnel and driven 100 feet on the main fissure. About 50 feet above intermediate tunnel is an upper tunnel 75 feet in length on the vein, which has been stoped to the top of the mountain. It is reported that the production from the workings amounted to about $200,000 in silver. Four men are employed by Christopher Baker of Silver Lake, who has a lease on the mine. Owner, Mrs. Frank Riggs of 1801 Oxley street, South Pasadena, California.

Avawatz Crown Mine. Silver Lake district. Situated 8 miles east of Riggs, a station on Tonopah and Tidewater Railroad. The main ledge is a highly brecciated quartzite, having a total width of 210 feet, and exposed for a distance of several thousand feet. Shaft was sunk 325 feet deep and a crosscut driven from the 300 foot level, which cut the brecciated zone for a distance of 210 feet, and the entire zone was found to be mineralized with silver bearing galena. The richest portion of the ledge is next to the hanging wall, sample of which gave an assay result of 150 ozs. silver and 20% lead, with 5½% copper and 6% zinc. This entire width of breccia shows an average of 4 ozs. silver and 8½% lead. There is a wagon road from mine to railroad, a distance of 11

[1] In description of mines of Calico district have made free use of the report of Waldemar Lindgren's report on "The Silver Mines of Calico," Trans. Am. Inst, Min. Engrs., Vol. XV, p. 718.

miles. Owner, Avawatz Consolidated Mines Company; Alvin B. Carpenter, president; M. L. Neely, secretary; offices, Citizens National Bank Building, Los Angeles, California.

Bell Gilroy Mine. Trojan district. It is situated 22 miles northwest of Fenner, a station on the Santa Fe Railroad, on the eastern slope of the Providence Range of mountains. Elevation 4350 feet. Holdings consist of three claims. The country rock is carboniferous limestone, the ore deposit being argentiferous galena in a silicified limestone breccia near a contact with intrusive monzonite. The breccia occupies a shear zone 400′ to 600′ wide, the strike of this being north and south and a dip of 30 to 40 degrees towards the east, but the dip of the seams of ore varies greatly. The main ore bodies occur on intersection of north and south fissures with east and west fissures. The main fissures are 8 feet wide, and the ore is stated to have carried 20 ozs. silver, and 6 to 12% lead. A number of tunnels have been driven on the various fissures at different elevations, none of which is over 150 feet in length. Approximately there are about 500 tons of ore on the dumps which is reported to assay 10 ozs. silver and 6% lead. With systematic development the property could be made a producer. Idle. Owner, A. A. Irish, 514 Grosse Building, Los Angeles, California.

Bismark Mine. Calico district. It is situated 5 miles northwest of Yermo, on San Pedro and Salt Lake Railroad, on the divide between Bismark Cañon and a branch of Wall Street Cañon. Chlorides and chloro-bromides of silver occur in irregular fractures in mineralized zone along a fault fissure. This fault fissure can be traced one mile to south of workings. This fault, the course of which is N. 17° W., dip 30° W., separates a heavy mass of brown tufa on the west from a light, well stratified tufaceous sandstone. The ores of the Bismark are cerargyrite, and a little chrysocolla, occurring in a gangue of barites. There are no well defined walls, but only one striated dividing plane, along which the ore bodies lie. The later are found on both sides of the plane, although most frequently on the east in the sandstone, and are usually irregular with a width not exceeding 8 inches. Developments consist of shaft 100 feet deep, and series of open cuts and tunnels. Owner, J. R. Lane of Calico, California.

Bonanza King Mine. Trojan district. It is situated 25 miles east of Fenner, a station on the Santa Fe Railroad, on the eastern slope of the Providence Range of mountains. Elevation 4200 feet. Holdings consist of 12 claims. Irregular lenticular ore bodies in carboniferous limestone occurring along a series of parallel north and south fissures, these fractures or fissures are near the contact of limestone and monzonite, and run parallel to the contact. The ore occurs as lead carbonate, chloride of silver, and chloro-bromide of silver with small percentage of galena. There are three well defined fissures known as Ray, Hogan and Peat, along which most of the ore has been found. Ore bodies along these fissures have a width of 4 to 20 feet, with length of shoots from 50 to 200 feet. Ray and Hogan fissures are about 100 feet apart, while Hogan and Peat fissures are only 50 feet apart. All drifting has been to the south of the shaft, and the ore shoots have a general trend to the south. The fissures dip from 50 to 70 degrees to the west. Developments

consist of a vertical shaft 540 feet deep, with levels at 100′, 200′, 300′, 400′ and 500′; from the 500′ level a winze has been sunk on an incline to 800′ level.

All ore has been stoped out above the 200′ level to the surface. On the 600′ level a drift has been driven east 150 feet to contact of lime and monzonite. The proven ore zone on the property is 1000 feet in length by 400 feet wide.

It is stated that early day shipments averaged about 100 ozs. in silver. The property was purchased by present owners in 1914 and operated until June, 1920, when operations were suspended. On the property there is about 8000 tons of dump ore stated to carry 10 ozs. silver with 1% lead, and 5000 tons of tailings assaying 10 ozs. silver.

Mine equipment consists of 25-h.p. gas engine hoist, 14″ x 12″ Ingersoll-Rand compressor driven by 60-h.p. Fairbanks-Morse engine, 2-stage triplex pump driven by 15-h.p. motor. Mill 10″ x 20′ Blake crusher, 5′ x 4″ Allis-Chalmers ball mill, Dorr classifier, two 12′ K. and K. flotation machines, one 8′ K. and K. flotation machine, one Overstrom concentrator, 60-h.p. motor drives Ball mill, and Dorr classifier; 40-h.p. Western gas engine drives generator, rock breaker, flotation machines and concentrators. During 1919 a test run was made with mill on ore from mine and dumps; heads averaged 8 to 10 ozs. silver, making a saving of 75%, producing a concentrate assaying 35 ozs., treating 40 tons daily. Some rich shipping ore was produced from the property during this later operation said to have carried 100 to 500 ozs. silver. Owners, Hall, Rawitser and Company, Acton, Massachusetts; home office care William Rawitser, 10 High street, Boston, Massachusetts.

California Rand Silver Mine. Rand mining district. The mine is 1½ miles southeast of Randsburg, ½ mile from Osdick Siding, on the Kraemer-Johannesburg branch of the Santa Fe Railroad, in section 6, T. 30 S., R. 41 E. There are 12 claims in the group. Elevation 3600 feet. The ore occurs in an irregular fault fracture in a quartzite dike which has a general course of N. 45° E. The strike of the ore body being N. 20° E. with a dip of 75 degrees east. An incline shaft has been sunk on this fracture to a depth of 300 feet. At a depth of 90 feet passed through the oxide zone, and encountered primary sulphide ores, in the form of argentite, pyrargyrite, and stephanite, associated with stibnite.

The silver sulphides have evidently replaced the antimony sulphide (stibnite) as where there is a large proportion of stibnite in the rock, the ore is low grade. Width of ore body was from 12 to 16 feet, and shows a length of 100 feet, on 90 foot level. On 50 foot level drift north 50 feet and drift south 50 feet in ore. On this level at a point 10 feet north of shaft, crosscuts driven 60 feet into footwall schist, and 50 feet east into hanging wall schist. Levels have been driven on 50′, 90′, 150′, 200′ and 250′. First carload of ore was shipped from the property June 15, 1919, to Selby smelter, returns on which gave 0.24 ozs. gold, and 50 ozs. silver per ton. On November 14, 1919, $250,000 worth of ore had been shipped to smelter from a depth of 90 feet. The mine to date has produced about one million.

Equipment, 25-h.p. gasoline hoist, Ingersoll-Rand compressor. From 30 to 50 men are employed. Owner, California Rand Silver Mining

Company, John W. Kelly president; Edith F. Coons, secretary; Morris B. Parker, consulting engineer.

Carbonate Hill Group of Mines. Holcomb Valley district. These mines are situated 43 miles east of Victorville, in the San Bernardino Range of mountains. Elevation 7500 feet. Eight claims are located on what is known as Carbonate Hill, which lies east of Van Dusen Canyon. The formation of Carbonate Hill is limestone, with numerous intrusions of porphyritic rocks. Both the limestone and intrusions have an easterly and westerly strike, and a northerly dip, varying from 30 to 45 degrees. Most of the porphyry dikes on the hill seem to have been intrusions along the bedding planes of the limestone. The limestone has been thoroughly metamorphosed into marble. The porphyritic dikes are numerous, nowhere obtaining a very great width, along the contacts the limestone and these porphyry dikes are found lenses of lead carbonate ore with occasional bunches of galena. A number of shafts, none over 50′ deep, and short tunnels have been run on these contacts and some small lenses of ore developed. A crosscut tunnel 460 feet long was run from Van Dusen Cañon to intersect these ore shoots, but after striking one of the porphyry intrusions work was suspended before reaching the ore zone. Some of the veins on the surface showed a width of 3 feet. Samples taken from these outcrops reported to assay 20 ozs. silver with 12 to 20% lead. Idle. Owners, C. L. Metzger and R. H. Gilman, 1682 West Twentieth street, Los Angeles, California.

Garfield and Thunderer Mines. Calico district. They are situated 5 miles northwest of Yermo, a station on the Salt Lake Route, on ridge west of Odessa Cañon. The divide between Bismark and Odessa Cañons is mainly built up of massive violet brown liparite. In this liparite occurs a series of ore deposits, somewhat different from the Odessa and Silver King ore zones. The ore occurs in fractures and crushed zones of rock, usually cementing the fragments. These zones are connected with a distinct fault plane. The Garfield Mine is entirely in liparite connected with a fault plane running NW. and SE. Some ore was found along main fault, but the largest bodies lie on the south side of it. The whole forms a zone of numberless irregular fissures in the liparite. Silver ores occur mainly on these cracks, and the whole often appears as a breccia of liparite, cemented by the gangue and argentiferous minerals. The ore bodies are extremely irregular from mere seams to a width of 40 feet. The argentiferous minerals are as usual cerargyrite and imbolite. Besides these chrysocolla and barite always occur. The ore bodies are formed on both sides of fault plane.

Developments: At an elevation of 2800 feet, is lower Garfield tunnel 4000 feet long. At a higher elevation (approximately 100 feet vertically) is an upper tunnel 2500 feet in length. In lower Garfield large chambers are found on both sides of main fault, 200 feet long by 40 feet wide. In upper tunnel there is a chamber 300 feet long by 40 feet wide. Idle. J. R. Lane of Calico, California, owner.

Imperial Lode Mine. It is in Lava Beds district, 9 miles southwest of Lavic, a station on Santa Fe Railroad. The lode is exposed for a distance of 8000 feet, cropping boldly above the surface for entire distance. It strikes NE. and SW., and dips NE. The claims are the Desert Queen, Mammoth Chief, Meteor, Morning Star and Sampson.

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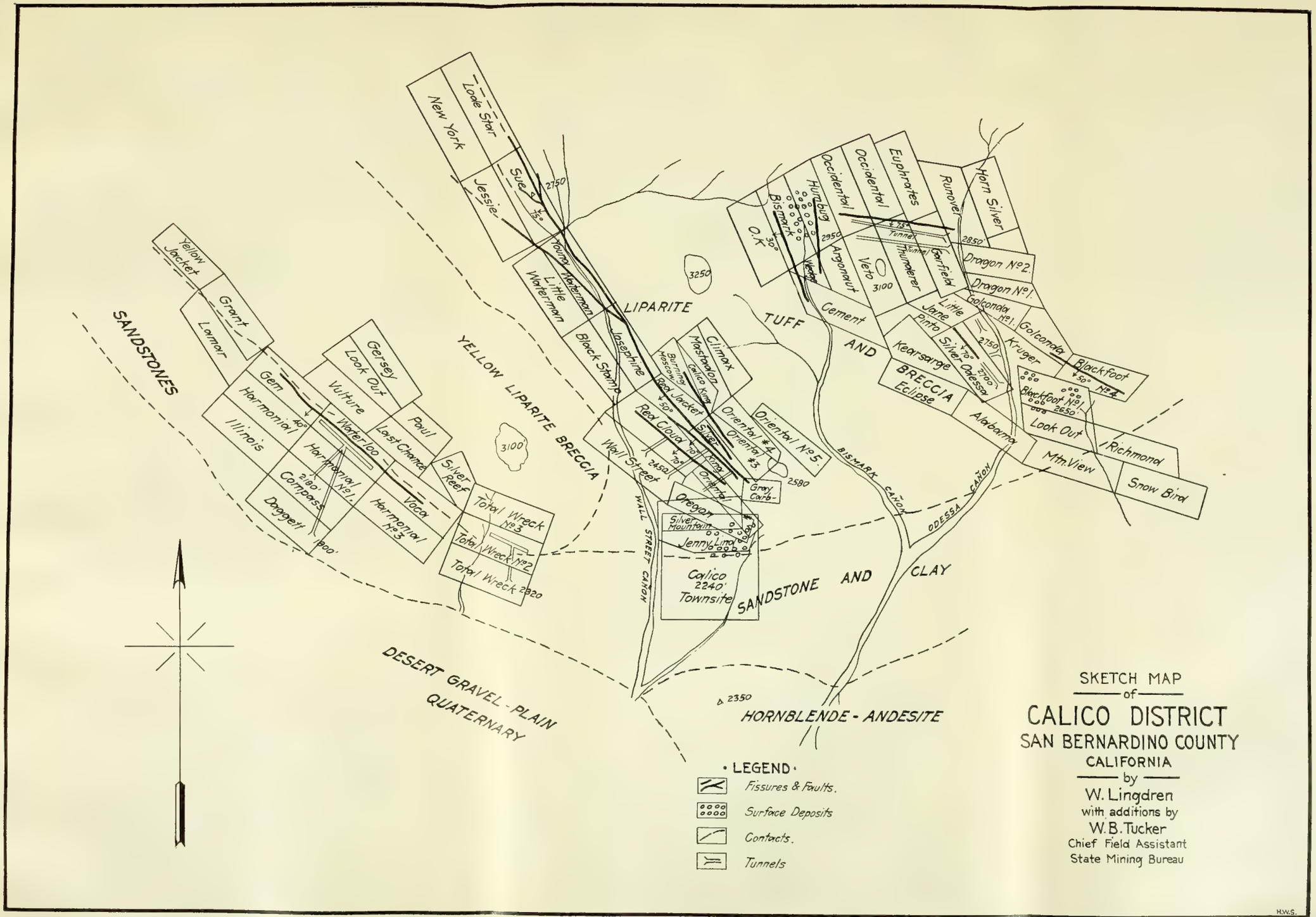

Plate VI. Sketch Map Calico District, San Bernardino County.

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The Mammoth Chief, Meteor and Morning Star claims are extensively developed by tunnels, shafts, and open cuts. The ores occur as chloride, argentite accompanying pyrite, chalcopyrite and iron oxides. The silver sometimes occurs with copper glance in small bunches in solid masses of lead carbonate. Twelve men employed on development work. William Dickeman of Ludlow, California, manager.

Bibl.: Rept. XI, pp. 349-354.

Mohawk Mine. Ivanpah district. It is situated on west slope of Mohawk Hill, 24 miles north of Cima. Holdings consist of 8 claims. Elevation 4500 feet. Several veins of lead carbonate ore occur in limestone. The veins appear to be parallel to the bedding along contact of a gray lime and an older bluish limestone. Underlying the limestone is granite, forming the core of the mountain. Strike of main vein is S. 15° E., dip 30° westward. The ore is a sandy carbonate, often running up to 30% lead. No ore is shipped that runs under 16%. A tunnel is driven on this vein 100 feet. The ore body is stoped to surface. A winze was sunk 80 feet on the ore body, and at a depth of 40 feet connected to surface by drift. In the bottom of winze ore body exposed for widths of 7 feet. Value of ore shipped from these workings in 1917 was $70,000; croppings can be traced on the surface for 1500 feet. Company plans to drive a tunnel on vein from west end at a point about 200 feet below apex. This should open a large ore body. About 1500 feet west of these workings is a shaft 140 feet deep, and an adit connects with bottom of shaft. Tunnel driven N. 20° E. in an ore body of zinc carbonate (20% Zn) opened for 40 feet, showing a width of 20 feet. The zinc ore occurs on the footwall of the lead vein. Large amount of low grade ore is exposed on the dumps and in the old workings, as only the richer portions were shipped. Ore is hauled to Cima. Owner, Ivanpah Copper Company; Dan Murphy, president; G. Holteroff, secretary; offices, Los Angeles Trust and Savings Bank Building, Los Angeles, California.

Odessa Mine. Calico district. It is situated 3½ miles northwest of Yermo on Salt Lake Route, on slope of ridge west of Odessa Cañon. Elevation 2700 feet. Ore bodies are found in bunches, or pockets, varying from small deposits of nominal value to large ore chambers. Ore bodies occur on intersection of fissures running in all directions through the rock mass, the fissures intersect main fault fracture, and another system runs parallel to main fault plane. The main fault fracture strikes N. 40° W. and dips 50° SW. Chlorides and chlorobromides of silver with traces of copper in form of malachite and crysocolla are found along the seams and fractures in the rock mass. Main Odessa tunnel is 600 feet in length, driven on main fault fissure. Ore stoped out from tunnel level to surface. A number of winzes have been sunk from tunnel level to depths of 100 feet on vein. Two other tunnels have been driven at lower elevations, 150 to 200 feet in length. Owner, J. R. Lane of Calico, California.

Oriental Group of Mines. Calico district. It is situated at Calico, 3½ miles northwest of Yermo, station on Salt Lake Railroad, on southwest slope of King Mountain. Elevation 2500 feet. There are 12 claims in this group. The Oriental vein lies in the King fault system

and intersects the Silver King vein near the southeast corner of the Silver King claim. Ore occurs along a complex system of filled fault fracture, consisting of a series of irregular fissures and fractures running in all directions, and the crushed mass is mineralized with silver chloride with a barite gangue. These ore deposits have been developed by nine tunnels, all of which are crosscut tunnels to vein system with drifts north and south along fault fissure. The vein system strikes N. 40° W., and dips 70° south. Ore shoots are irregular, widths varying from 8 inches to 50 feet. The greatest vertical depth below outcrop is about 700 feet. The most recent developments have been on No. 9, or Wall Street tunnel, level. On this level crosscut driven 360 feet to vein, with drift 360 feet NW. and 720 feet SE. A winze

Photo No. 43. View of Oriental and Silver King Mines, Calico District, Calico, San Bernardino County, California.

has been sunk from the level 200 feet on an incline of 70 degrees, at 100 feet below the collar of winze a drift has been run NW. 300 feet, and SE. 350 feet on a narrow barite vein. At bottom of winze a drift was run NW. 50 feet and SE. 50 feet. During early part of 1919 seven cars of ore were shipped from these workings, which averaged 30 oz. silver per ton. Property is under lease to D. B. Gemmel, 1002 Hibernia Building, Los Angeles, California, who has installed a cyanide plant for treatment of mine fills. The ore is being drawn from stopes on No. 6 level, which are reported to run from 6 to 8 ozs. in silver. Ten men are employed. Owner, J. R. Lane of Calico, California.

Perseverence Mine. Trojan district. It is 22 miles northwest of Fenner, a station on the Santa Fe Railroad, in the Providence Range of mountains. Lies northeast of the Bonanza King mine. Holdings consist of 12 claims. The ore bodies occur as irregular lenses of chlorides and bromides of silver and argentiferous galena on contact of limestone and granite. These deposits vary in width from 2 to 10 feet. General strike of the ore zone is N. 45° E., and fissures dip 75° E. to vertical. Developments consist of shaft 162 feet deep with levels at 40′, 72′ and 160′, with 1350 feet of cross-cuts and drifts.

Equipment, 8-h.p. gasoline engine, 9″ x 8″ compressor driven by a 25-h.p. gas engine. Idle. Owner, Orange Mining and Milling Company, M. L. Eltistie, president; Gay Richards, secretary, Orange, California.

Silver King Mine. Calico district. It is situated at Calico, on the southwest slope of King Mountain, 3½ miles northwest of Yermo, a station on Salt Lake Railroad. Elevation 2600 feet. Claims: Silver King, Red Jacket, Josephine, Calico King, and Burning Moscow. Ore deposits occur on the King system of fault fractures. Complex fracture can be traced NW. and SE. through these claims. They are a divergent form of fractures. Towards the southern end of the system considerable faulting has followed the fracturing; and it is noted that King Hill with its bold, rocky face and step faults indicates a throw of 500 feet. Ores found along these fissures are all similar in character. A gangue of barite and jaspery silica encloses more or less regularly chlorides and chloro-bromides. Manganese minerals are common. The cerargyrite and embolite mostly occur as thin coatings in joints and cracks, but often embedded in the barite. At the northern end of the system the deposits occur as typical fissure veins with well-developed walls. The fissures occur in brownish liparite. Going southeast from the north end mines along the fissure, evidence of increased faulting and extensive crushing of the rock is encountered. The crushing evidently reached its maximum about the Red Cloud and Red Jacket mines. Here the liparite is in places completely disintegrated and brecciated; on innumerable cracks and fissures running in all directions barite and jasper are deposited; and although the main deposits are connected with the main fault planes, there are numerous smaller veins and pockets in the neighborhood. On the Silver King the dislocation has been large, resulting in step faults with successively smaller throw. The hanging wall of first fault is a liparite brecciated tufa. The other fissures are all in a fractured and brecciated liparite. The fissures crop boldly on King Hill, striking 35° to 65° W. of N., dip 70° S. The ore bodies follow the fissures, but there is no true fissure vein. The gangue of the ore is impregnated in crushed rock, mostly in hanging wall of the well-developed fault plane, and form irregular ore bodies 20 to 50 feet wide, again contracting to a narrow seam along footwall. On the sixth level the most southernly fault branches; the main fault runs through Red Jacket, while another continues through the Burning Moscow in northerly direction. Developments consist of shaft 500 feet deep on 70° incline, the mine is also opened by series of cross-cut tunnels from Oriental Mine, which intersect the King vein on the 4th, 6th, 7th, 8th and 9th levels. There has been about 6000 feet of drifts and cross-cuts on the vein system. Owner, Waterloo Mining Company, care Upham, Black, Russell and Richardson, Mills Building, Milwaukee, Wisconsin.

Silver Rule Mine. Resting Springs district. The mine is situated at an elevation of 4800 feet, on the southwest slope of Kingston Range of mountains, 17 miles east of Morrison's Siding on the Tonopah and Tidewater Railroad. Holdings consist of 5 claims. Carbonates of lead and zinc occur along a fissure in dolomitic limestone, which strikes

NW. and SE., dip 75° north. Width of ore being from 3 to 15 feet. The lead ore carries silver values. The lead and zinc ore bodies are distinct, being separated by a gouge. Ore is reported to carry 10 ozs. silver, 20 to 40% lead, and 7% zinc.

Developments consist of two tunnels, upper tunnel 220 feet in length, and at 75 feet vertically below is a lower tunnel 400 feet in length. The ore shoot developed on the upper tunnel was 25 feet in length and 6 feet wide, ore averaged 40% lead, 10 to 15 ozs. silver, with small amount of gold. Idle. John Chambers, Tecopa, California, owner.

Silver Lode and Black Water Mines. Resting Springs district. These mines are situated on the northeastern slope of Kingston Range of mountains, 17 miles west of Ripley, Nevada. Elevation 4600 feet. There are 4 claims in the Black Water group and 6 claims in the Silver Lode. Lead carbonate ore occurs as irregular lenses along contact of granite and limestone. Strike NW. and SE., dip 60° NE. Developments consist of a cross-cut tunnel 350 feet in length driven to cut the contact on the Silver Lode claim. About 2000 feet east of this tunnel, a shaft has been sunk on the Black Water claim to depth of 100 feet on a fracture in the limestone. The ore is a lead carbonate with occasional bunches of galena, stated to assay 12 ozs. silver and 20% lead. Six men employed. John Chambers of Tecopa, California, owner.

War Eagle Mine is 9 miles north of Bagdad, a station on the Santa Fe Railroad. Elevation of 1800 feet. Ore occurs along a fault fissure in porphyry, strikes east and west. Width of ore deposits from a mere seam to 30 feet. Ore occurs as chloride and sulphide of silver with galena.

Developments consist of shaft 700 feet deep, with over 7000 feet of drifts and crosscuts. Equipment consists of 35-h.p. gas engine hoist; twenty-five-ton concentration mill. Ten men are employed. Shipping concentrates. Owner, Southwestern Lead Company, I. W. Hellman Building, Los Angeles, California; D. L. Williams, general manager.

STONE INDUSTRY.

Granite occurs over considerable areas in San Bernardino, but is quarried only at Decliz, Oro Grande and Victorville. For detailed description of deposits the reader is referred to the following publications: Bulletin No. 38, pp. 48 to 51; Report XV, pp. 896–898.

Russell-Greene-Foel Company, Pacific Electric Building, Los Angeles, California, are operating the Declex quarry, 9 miles west of Colton. The stone is quarried for use as ballast, rubble and riprap.

STRONTIUM.

Beds of celestite (strontium sulphate) are stated to occur associated with colemanite layers at the borax mines of the Pacific Coast Borax Company at Calico. Large deposits of celestite occur in the lake beds containing salt and gypsum in the Avawatz Mountains, on the holdings of the Avawatz Salt & Gypsum Co., of Los Angeles, California. A

large deposit of celestite occurs 2 miles north of Argos Station, on the Santa Fe Railroad, and about 6 miles from Ludlow. Strontianite occurs in clay beds 10 miles north of Barstow.

Avawatz Mountains Celestite Deposits. Situated in Avawatz Mountains, 10 miles northwest of Silver Lake. The principal outcrops of celestite are near and west of what is known as the Jumbo salt outcrop. The celestite is exposed in the form of resistant "hog backs" in some places flanking the ridges, and in other places cutting through and continuing across the valleys between them. Thickness of the celestite zone is from 75 to 80 feet. The exposed reefs of celestite are dark brown in color, compact and crystalline. General strike of the beds follows the north edge of the Avawatz Mountains. (Quoted from W. C. Phalen's Report, U. S. G. S. Bull. 540, pp. 526–531.)

The deposits are of great extent, and a large tonnage can be developed. Owner, Avawatz Salt and Gypsum Company, Kerckhoff Building, Los Angeles, California.

Ludlow Celestite Deposits. It is situated 4 miles north of Argos Siding, on the Santa Fe Railroad. The beds of celestite are said to be 12 to 20 feet thick, and of great extent. Some ore was shipped from these deposits during 1918 by Ellis Mallery, H. W. Hellman Building, Los Angeles. Ownership in dispute; probably on railroad land.

TALC.

Amargosa Group of Talc Mines. These deposits are located 1¼ miles south of Acme, a station on the Tonopah and Tidewater Railroad, on a ridge west of Amargosa River, in Painted Cañon. Two claims have been located under the names of White Cap and Snow Drift. A vein of high grade talc 2 to 12 feet in width occurs on contact of limestone conglomerate and diorite. Strikes N. and S., dip 45° E. Talc is high grade, and white in color with low lime content. Developed by two tunnels; on lower tunnel vein drifted on 200 feet, in upper tunnel 150 feet. Fifty-five cars were shipped to Los Angeles in 1918. Idle. Owner, W. W. Hite, and Thomas Coghland of Tecopa, California.

Acme Talc Mine. It is situated 7 miles east of Acme Siding, on Tonopah and Tidewater Railroad, and 8 miles southwest of Tecopa, in low Desert Range of hills, east of Amargosa River. Deposits of pure white talc of good quality occur along contact of limestone and diorite. The outcrop can be traced for a length of six claims. The general strike of the ore deposits is N. 30° W., dip 45° E. The outcrop shows a width of 20 to 50 feet. On the south end of property, a tunnel has been driven northwest 400 feet in talc, about 200 feet vertically below outcrop on hill. Vein in these workings shows a width of 20 feet, and has been stoped to the surface. To the northwest of these workings about ¼ of a mile, a number of tunnels and open cuts have been made on the same vein, all of which produced a large amount of ore. A new deposit is being developed about one mile west, on a parallel vein. At this point an open cut has been made along the outcrop, a distance of 200 feet, which shows a width of 15 feet of talc. Talc hauled

to Acme station by 5-ton trucks, from which point it is shipped to the company's grinding plant at West Glendale. Here it is pulverized, producing three grades, and shipped to consumers in the east. The deposit is being worked under contract by George Morton. Shipping 40 tons per day from deposit. Owner, Pacific Minerals and Chemical Company; L. Lindsey, president; Hugh McPhee, secretary, West Glendale, California.

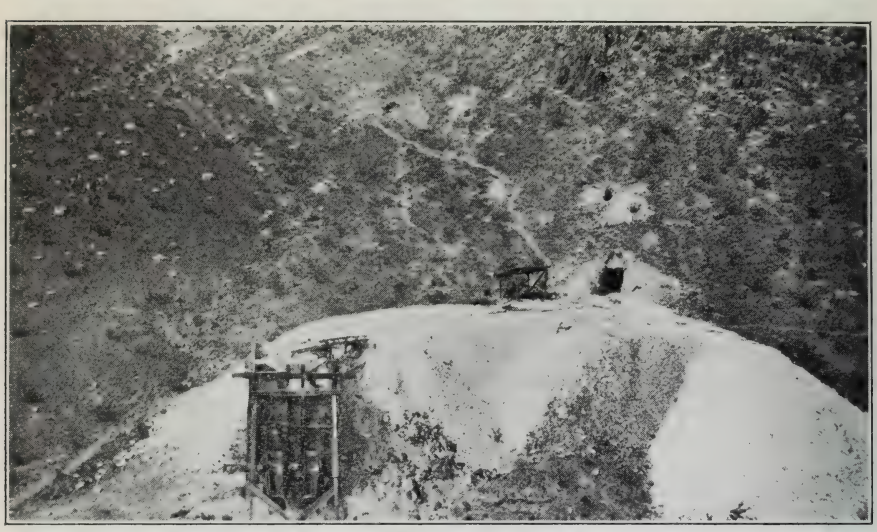


Photo No. 44. Acme Talc Mine. View of adit and outcrop of talc vein. Seven miles east of Acme, Inyo County. Pacific Minerals and Chemical Company, owner.

Gould Talc Deposit. It is situated in township 17 N., R. 10 E., 10 miles northeast of Silver Lake on the west slope of Shadow Mountains. Holdings consist of two claims. The deposit lies on and near the contact of limestone and diorite and can be traced for the full length of the claims. Fibrous and nonfibrous material, talc and tremolite strikes NW. and SE.; 5 to 8 feet in thickness, very white. These shafts have been sunk along the outcrop to depths of 30 to 40 feet. The deposit lies west of the Pacific Coast Talc Company's holdings. Owner, C. O. Gould, 615 East Main street, Stockton, California.

Sheep Creek Deposits. These deposits are situated 12 miles west of Riggs, a station on the Tonopah and Tidewater Railroad, and 20 miles northwest of Silver Lake, in the Avawatz Range of mountains. The talc deposits in this region occur on contact or very close to a dark basic igneous rock, probably a diorite and a belt of impure limestone. The talc is pure white to light gray in color, and varies in hardness from solid outcrops, which are moderately hard, and to very soft crumbly masses. The talc near the intrusive rock is usually the purest. Four deposits occur in this region, the three largest being on Sheep Creek, and the fourth is northeast of Jumbo salt deposit. The deposit at the mouth of Sheep Creek is in impure limestone zone about 125 feet in thickness. Most of the talc is found in the fifty feet next to the igneous intrusion, the best being at the contact. Of this 50 feet about

25 feet is talc of the soft and hard varieties. A cut near the top of cliff has penetrated the talc for 15 to 20 feet. About ⅔ of talc is soft white talc, the other ⅓ being hard gray talc. Outcrop can be traced for 1500 feet. Fibrous and nonfibrous material, talc and tremolite. Very white in color, and pure, strike is NW. and SE. A large tonnage can be developed on the different deposits.

It is estimated that approximately 400,000 tons can be mined from these deposits. Analysis, U. S. G. S.:

SiO_2	=	6020%
MgO	=	27.98%
CaO	=	2.60%
Al_2O_3	=	1.25%
Fe_2O_3	=	2.50%
H_2O	=	5.70%

Owner, Avawatz Salt and Gypsum Company, Kerckhoff Building, Los Angeles, California.

Talc Product Company Deposit. The deposit is situated 2¼ miles east of Love Siding, on the Tonopah and Tidewater Railroad, in Shadow Range of mountains. Talc deposit can be traced NW. and SE. It occurs on contact of limestone and diorite. The body has a thickness of 5 to 8 feet. It is a slippery foliated talc. Its derivation from tremolite schist suggests that the talc deposit will persist in depth.

Analysis, U. S. G. S.:

SiO_2	=	63.36%
MgO	=	27.60%
CaO	=	3.49%
Al_2O_3	=	.46%
Fe_2O_3	=	.09%
FeO	=	.30%
H_2O	=	3.92%

The company has a grinding plant at 2480 Hunter street, Los Angeles, California. Owner, Talc Products Company; Harry M. Thompson, president; Everill C. More, secretary; W. H. Moody, manager, 752 Washington Building, Los Angeles, California.

Tremolite Mine (Pacific Coast Talc Company Deposit). It is situated 10 miles northeast of Silver Lake, and 7 miles southeast of Riggs Station, on the Tonopah and Tidewater Railroad, on the northwest slope of Shadow Mountains. Elevation 2300 feet. Five claims have been located, known as Tremolite No. 1 to No. 5. The talc is remarkable for its whiteness, mode of occurrence and origin. The deposit can be traced NW. and SE. for nearly a mile. It lies between limestone and diorite, although there is much granitic and aplitic intrusions, as well as mica schist and other metamorphic rock nearby. The body has a thickness of 5 to 10 feet, and is well banded, as it is stratified parallel to overlying limestone. Vein dips 55 degrees south. Shaft No. 1 has been sunk on an incline of 58 degrees to a depth of 120 feet on the vein, and drifts driven on the vein on two levels. About 2000 feet east of No. 1 shaft, No. 2 shaft has been sunk to depth of 40 feet, developing 5 feet pure white talc. There are two parallel veins, known as footwall and hanging wall veins, which are about 25 feet apart with a belt of hard tremolite between.

Analysis, U. S. G. S.:

SiO_2	=	60.88%
MgO	=	28.85%
CaO	=	4.28%
Al_2O_3	=	.36%
Fe_2O_3	=	.10%
FeO	=	.33%
H_2O	=	4.50%

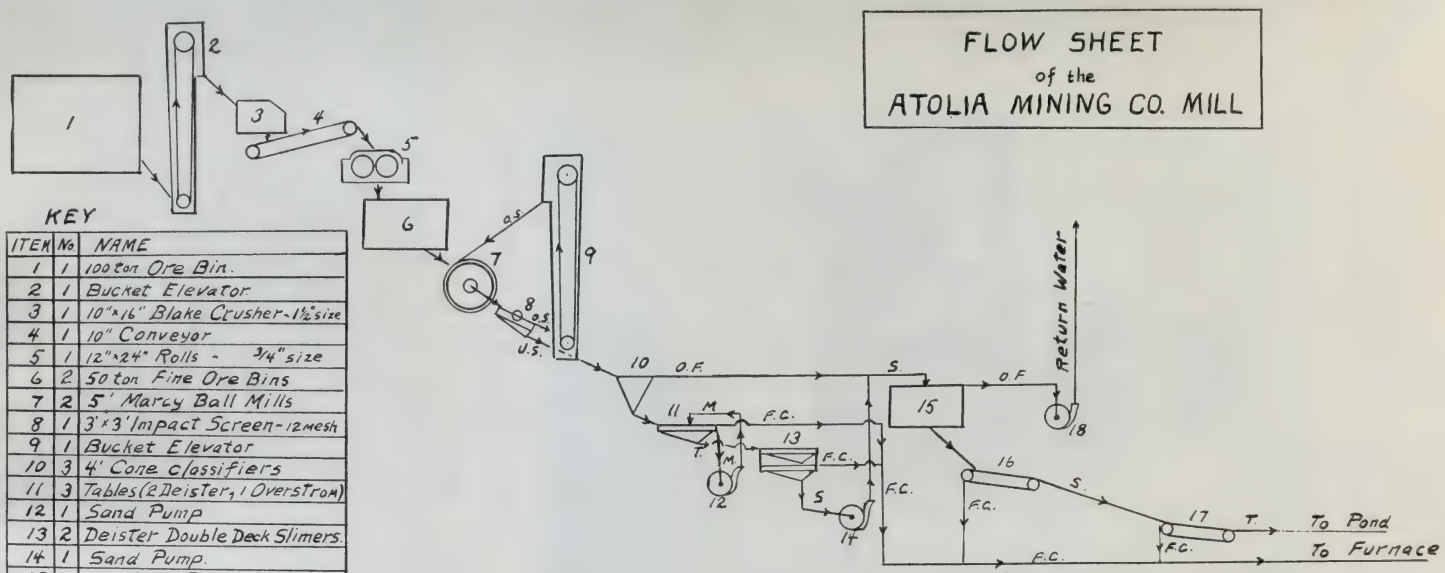
Company has a grinding plant at 2149 Bay street, Los Angeles, California. Thirty-two tons are shipped daily from the property to Los Angeles. Ten men employed. John J. Rogers, superintendent. Owner, Pacific Coast Talc Company, George T. Walker, president; A. M. Algeo, secretary; R. W. Glending, vice president and general manager, 2149 Bay street, Los Angeles, California.

TUNGSTEN.

San Bernardino County was the largest producer of tungsten in the state, from 1906 until the early part of 1919, when the market price fell to $7 to $10 per unit, thus causing all the producing mines to suspend operations, and there is no mining activity at present writing in the tungsten bearing areas of the county.

The deposits at Atolia are the largest scheelite deposits known, while the Clark Mountain and New York Mountain districts in eastern San Bernardino wolframite and hubnerite are the principal ores with some scheelite. For detailed descriptions of these districts and the different mines see Report XV, pp. 830–849. Only those properties will be discussed that later developments of importance have occurred, and properties not reported on in previous reports.

Atolia Tungsten Mine. This has been the most productive mine in the county, and the company owns 97 claims in the Atolia district. The scheelite occurs in a series of parallel more or less overlapping veins in a zone of granite 2 miles long and about 2000 feet wide, striking about 10° south of west, dipping from 13° to 80° north. The individual veins are not continuous throughout the zone, but occur as shoots up to 1000 feet in length. The veins vary from mere seams up to 6 feet in width. Occasionally they open into larger bodies. The vein materials associated with the scheelite are quartz and calcite. The deepest working is No. 1 shaft. This is a two compartment shaft sunk to a depth of 1000 feet on the vein (incline on 69° to 450 feet, then flattens to 39 degrees to the 1000 foot level). At 950 feet the shaft goes into the footwall, and a short crosscut to cut the vein. Mine practically stoped out above the 800′ level. Between 900′ and 1000′ levels two large blocks of ore have been developed, one east of shaft 200 feet long and 4 feet wide, other west of shaft 200 feet in length and 5 feet in width. East of shaft the vein is intersected by a series of north and south cross veins on breaks; at a number of places the vein has been faulted. On the 900′ level the vein is drifted on about 1000 feet. Ore treated in 100-ton concentration mill, said to have averaged 6 to 7% WO_3. Concentrates average 60% WO_3. Phosphorus content averages .12% and must be reduced to .04%. Sulphur content must not be over 1%. To reduce the phosphorus content, portion of concentrates are treated in vat with



KEY

ITEM	No.	NAME
1	1	100 ton Ore Bin.
2	1	Bucket Elevator
3	1	10"×16" Blake Crusher-1½" size
4	1	10" Conveyor
5	1	12"×24" Rolls - 3/4" size
6	2	50 ton Fine Ore Bins
7	2	5' Marcy Ball Mills
8	1	3'×3' Impact Screen-12 Mesh
9	1	Bucket Elevator
10	3	4' Cone Classifiers
11	3	Tables (2 Deister, 1 Overstrom)
12	1	Sand Pump
13	2	Deister Double Deck Slimers.
14	1	Sand Pump.
15	1	30' Dorr Thickener
16	9	Vanners
17	12	Vanners (Lower Plant)
18	1	Water Pump
O.S.		Over Size
U.S.		Under Size
O.F.		Over Flow
F.C.		Finished Concentrate
M		Middlings
T.		Tailings
S.		Slimes.

Plate VII. Flow Sheet, Atolia Mining Company's Mill.

solution of $H_2 SO_4$ and H. Cl. Steam heated to 97° C. Liquid decanted and four washings of water applied. Then the concentrates are dried and introduced to reverberatory furnace to get rid of sulphur content. This being reduced to 0.16% S. Capacity of furnace 10 to 12 tons per 24 hrs. Owner, Atolia Mining Company; E. C. Voorheis, president; E. A. Stint, secretary, Humboldt Bank Building, San Francisco.

Photo No. 45. No. 1 Shaft, Atolia Mining Company, Atolia, San Bernardino County.

Black Hawk Tungsten Mine. This mine is situated in the Atolia district, 1 mile east of town of Atolia. The holdings consist of 5 claims, known as the Halloran and Leonard group, one of which, a patented claim, is the only break in the continuity of the main group of the Atolia Mining Company's claim. The scheelite veins on these claims are parallel and overlap each other, and are not continuous for any considerable distance. The veins vary from mere seams up to 3 feet in width. The scheelite is associated with quartz and calcite. Veins strike 10 degrees south of west and the dip varies from 20 degrees to 80 degrees north. Veins occur in the granite. Developments consist of three shafts. Main working shaft was sunk to a vertical depth of 500 feet, with idea of cutting the different parallel veins that were productive both east and west on the Atolia Mining Company's claim.

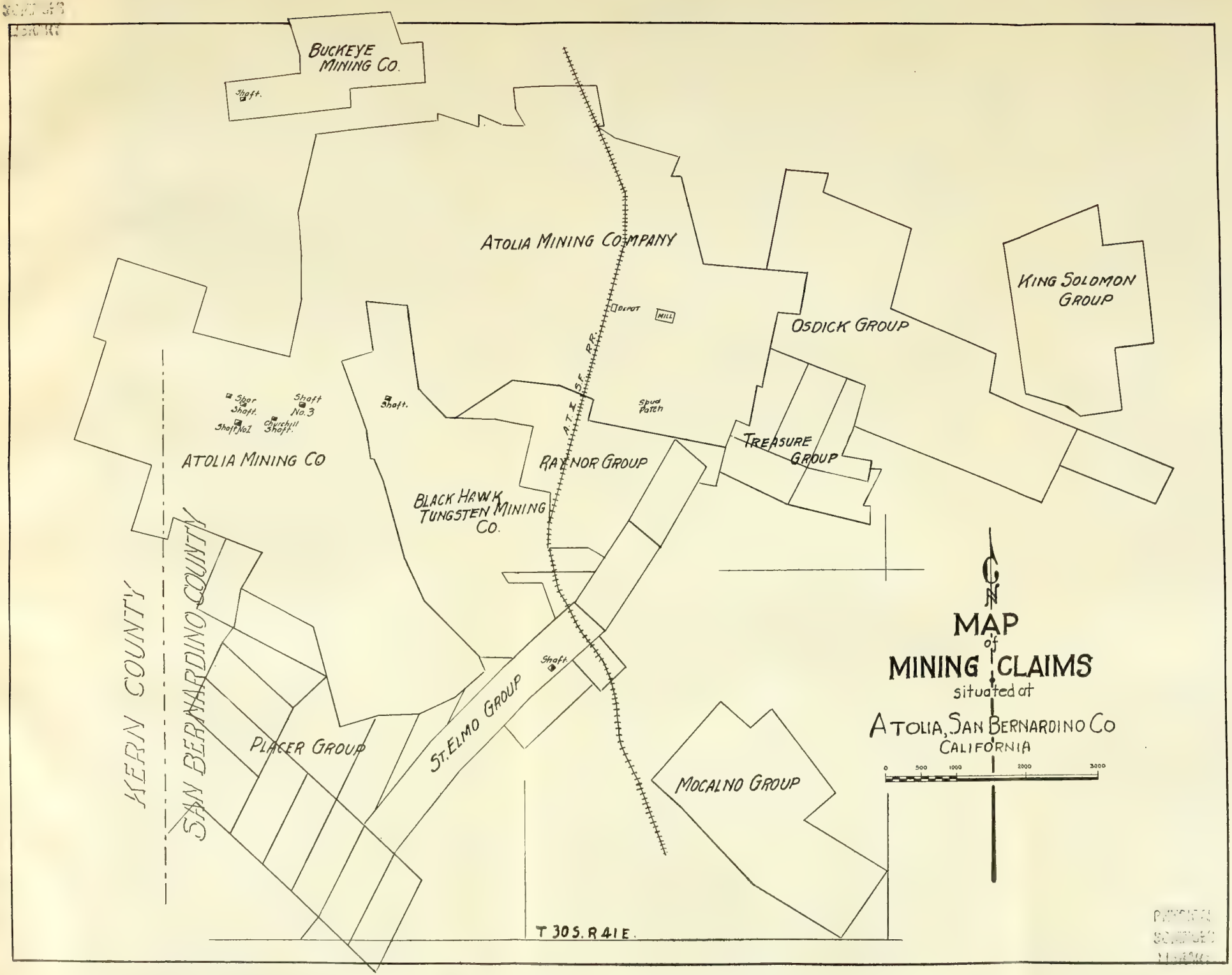


Plate VIII. Map of Mining Claims, Atolia, San Bernardino County.

Drifts were run on the 100′, 200′, 300′, 400′ and 500′ levels east and west on the different veins and seams, but no large shoots of ore were developed. A large amount of crosscutting was also done to the south without developing any ore. On the 500′ level a crosscut was run 500 feet south, which developed a small shoot of ore near the face. To

Photo No. 46. Eighty-Ton Mill, Atolia Mining Company, Atolia, San Bernardino County.

the south of this shaft two inclines were sunk to depth of 100′ and 160′. Some ore was shipped from these workings. Owner, Black Hawk Tungsten Mines Corporation, M. L. Conroy, president, 527 Front street, San Pedro, California.

Buckeye Tungsten Mine. It is situated 1½ miles southeast of Atolia, and to the north of the Black Hawk mine. Elevation 3400 feet. Three claims. Three parallel veins cut the granite, striking 10 degrees north of west, and dip northward. The three veins are about 50 feet apart, and vary in width from 2″ to 2 feet. The gangue is quartz and calcite. The vein matter carries scheelite, which appears to be disseminated throughout the quartz. The largest vein, the middle one, has been opened by trenches and cuts at intervals of 3000 feet along its strike. The deepest workings on it are two 50-foot shafts. Owner, Buckeye Tungsten Company, C. C. Ray, president, W. M. Keeling, secretary, Atolia, California.

Mojave Annex Tungsten Mines. It is situated on the north slope of the New York Mountains, 2 miles southeast of Brant, a station on the Salt Lake Railroad. Holdings consist of two claims in Cliff Cañon and a group of seven claims in the Clark Mountains. All work, however, has been confined to the Cliff Cañon claims. Wolframite is deposited in quartz stringers, varying from 1″ to 12″ in a pegmatite dike. The dike is 40 to 50 feet wide, dips almost vertically. The quartz stringers lie parallel to the dike. Between the wolframite bearing stringers shoots of quartz containing galena, ruby silver and some copper are encountered. Development work consists of a tunnel driven 100 feet along dike. The wolframite occurs in small crystals, and occasional irregular bunches. A 20-ton mill was built to concentrate the wolframite. Consists of Force feed jaw crusher, which reduces the ore to ½″ size,

then from bins ore goes to Davis rolls, and reduced to 10 mesh size. Then to Stebbins dry concentrator. Idle. Owner, Mojave Annex Tungsten Company, Joseph B. Evans, president; H. G. Parsons, secretary, 752 South Main street, Los Angeles, California.

United Tungsten Copper Mines. These mines are situated in the Morongo district on the eastern flank of the San Bernardino Range of mountains, 50 miles southeast of Victorville. Elevation 6800 feet. Thirty unpatented claims are held by the company. Minute crystals of scheelite occur in contact metamorphic veins between granite and limestone, often replacing the lime. The ore bodies are very irregular both in character and content, varying from well defined veins of a few feet in width to pockets of irregular and uncertain size. Scheelite is deposited in minute crystals in a soft epidote gangue. In the gangue are also calcite quartz and garnets. In this gangue is also found the carbonate of bismuth, bismutosphaerite. Developments consist of one main working tunnel 200 feet long, and several shorter ones, also two shafts on the vein of depths of 50 and 80 feet. Owing to the irregular character of the deposits, it does not appear that any amount of ore will be developed on the property. Idle. Owner, United Tungsten Copper Mines Corporation, 30 Broad street, New York City.

VANADIUM.

Vanadium ores are found in the Signal district, 8 miles north of Goffs at the properties of Lombard and Main, and at the Louisiana California Mine. The ore occurs here in gold quartz veins, and has been identified by Shaller as cuprodescloizite. The associated lead minerals are cerussite, and vanadinite. The occurrence is also noted 4 miles northeast of Klienfelter, a station on the Santa Fe Railroad on the Vanadium King Claims, owned by A. L. Moorhead, and W. F. Chausse of Goffs. It is reported the ore will assay 3% $K_2 O_5$. The ore is a vanadinite and pyromorphite. The occurrence is also reported in the Twenty-nine Palms district, in the gold bearing quartz vein of Gold Park Consolidated Mines Company.

Bibl.: XV Report, pp. 849-852.

SAN DIEGO COUNTY.

There has been very little mining activity in San Diego County since Report XV of the State Mineralogist was issued.

The principal mineral production of the county has been entirely confined to commercial minerals. The mineral output for the year 1919 being valued at only $343,230.

San Diego County contains valuable deposits of clay, copper, feldspar, gems, gold, lithia, marble, nickel and silica.

CLAY.

In the bluffs of Rose Cañon, about 10 miles north of San Diego, are extensive exposures of Eocene Tertiary clay or shale, which is suitable for the manufacture of common brick and tile.

The two brick plants operating in Rose Cañon being, Sunnyside Brick Company, W. A. Russ, owner; Thirtieth and Grape streets, San Diego, California.

Bibl.: Rept. No. 7, "Clay Industry of California."

Union Brick and Tile Company, J. W. Rice, secretary, 2166 Park avenue, San Diego, California.

Bibl.: Rept. No. 7, "Clay Industry of California."

Only a small amount of high grade clay is being produced at present in San Diego County, although there are a number of deposits of plastic and refactory clays in the neighborhood of Encinitas and Cardiff that are worthy of investigation.

On the **Kiellar Ranch** east of Cardiff, a station on the Santa Fe Railroad, a deposit of red mottled clay is being developed by the St. Luis Fire Brick Company, and shipments are being made from the deposit to the company's plant in Los Angeles, California.

Southern California Clay Products Company of Los Angeles are shipping clay from their deposit, 7 miles east of Encinitas.

Bibl.: Cal. State Min. Bur. Rept. No. 7, p. 93, "Clay Industry of California."

American Encaustic Tile Company of Los Angeles are working a deposit of feldspathic rock on McGinnes Mountain near Dehesa, and making occasional shipments to the company's plant in Los Angeles, California.

Bibl.: Cal. State Min. Bur. Rept. No. 7, p. 93, "Clay Industry of California."

Dinero Ranch Clay Deposit. It is situated 3 miles southeast of Otay, and 5 miles east of Nestor, a station on San Diego and Arizona Railroad, in sections 26, 29, T. 18 S., R. 1 and 2 W.

The deposit occurs as a massive clay-like variety of kaolin, containing a great amount of combined water. It is locally called otaylite, and it is probably halloysite, hydrous silicate of alumina. The material is

quite soft, is white, gray and red, and has a soapy feel. It appears to form a nearly horizontal bed, varying from 1 foot to 6 feet in thickness, a few feet below the surface of Otay Mesa, and underlying several hundred acres, outcrops of the material are noted at several points in the bluffs of the Otay River Valley. The material when exposed to the air disintegrates. One half a mile up the cañon from John Mosto's ranch, a large open cut 50 feet high by 200 feet long shows 6 feet of halloysite with 8 to 12 feet of soil overburden. The deposit is being worked under lease by the General Petroleum Company, and a large tonnage shipped to the company's refinery for use as a purifier of oils.

Owner, John Mosto, of Otay.

Otaylite Products Company, of 2026 Barranca street, Los Angeles, D. A. Hamburger, president, F. H. McCullough, secretary, were working a deposit of the same material to the south on the Jamul ranch. The beds are from 1 to 6 feet thick. Some of the material was shipped to the company's grinding plant in Los Angeles. The ground material is used for a cleaning compound, also softening of water, and as paint-filler.

COPPER.

Copper deposits are found at several points within the county, but to date no large deposits of commercial value have been developed.

The principal districts where copper ores occur are in the hills between Escondido and Encinitas.

For detailed description of deposits see Bulletin No. 50, pp. 344 to 345; Rept. XIV, pp. 665-669.

FELDSPAR AND SILICA.

There are a large number of deposits of feldspar associated with silica in the granite area of San Diego, most of which are some distance from railway transportation.

Owing to the increased demand for feldspar by the manufacturers of enamel wares and pottery, there should be an increased production of this material from the county.

William Stell of El Cajon owns a large deposit of feldspar and silica, on ridge south of Cottonwood Creek, near Marina Dam, about 5 miles north of Campo, a station on the San Diego Railroad. Here a bold outcrop of silica and feldspar, 100 feet wide, can be traced for over 1600 feet. Said to be over 100,000 tons of feldspar and silica that can be easily mined. Both feldspar and silica are of good quality and free from impurities.

M. A. Turner, of 928 Eighth street, San Diego, owns a deposit 5 miles west of Alpine, which is said to outcrop at a number of points within a distance of one mile along its general strike. In places it is about 25 feet wide. The principal outcrops are in section 35, T. 15 S., R. 1 E., S. B. B. and M. Quality of spar reported of high-grade material, with high potash content.

GEMS.

The gem industry of this county has at times attained considerable prominence, but production has been small for several years past, due to lack of demand. **Pala Chief Mining Company,** operating Pala Chief mine, being the only producer, and this being worked only at intervals, for the local market requirements. The Pala Chief mine is noted for the gem stone kunzite found in the pegmatite dikes on the property, also produces tourmalline and quartz crystals. Owner, Frank L. Salmons of San Diego, California.

For complete description of the gem minerals of San Diego County, see Report XIV, pp. 691-708; also California State Mining Bureau Bulletin No. 37.

GOLD.

The principal gold belt of the county lies in ranges 2, 3, 4 and 5 east, extends southward through a distance of 45 miles from the Rice or Montezuma district, east of Warner's, to the Mexican boundary. The principal mineralized area is near Julian and Banner. In the Cuyamaca Grant are several prospects, and the Stonewall mine, which has been a productive mine in the past. At Deer Park, Pine Valley and Descanso are a number of gold mining claims, as well as west of the Cuyamaca Grant on Boulder Creek. There is very little activity in gold mining in the county, but some prospecting development is going on in the Banner and Julian districts.

For detailed descriptions of mines and districts see Report XIV, pp. 646-665.

Apex Mine, near Julian, being developed by Schindler and N. B. Roff of Julian. Under lease from R. M. Melrose, of Julian, California. Development consists of cross-cut tunnel 300 feet to vein, with drift on vein for 50 feet. This mine was formerly known as the Empire, including the following claims: Homestake, and North Star.

Bibl.: Repts. XII, p. 243; XIII, pp. 342-345.

Golden Chariot Mine. Being reopened by R. D. McCulloch of Julian, California. Five-stamp mill on property.

Bibl.: Repts. VI, p. 86; IX, p. 147; XIII, p. 337.

North Hubbard Mine. It is $\frac{1}{4}$ mile southwest of Banner. Veins strike NW. and SE., cutting mica schist, width 12″ to $1\frac{1}{2}$ feet. Tunnel 500 feet in length and about 500 feet of drifts. Equipment, mill, 6″ x 10″ Dodge crusher, 5 stamps, one Standard concentrator. Six men employed. Owners, Frank Talbot, and Mark Brokenshine of San Diego, California; T. Lyon, superintendent.

Bibl.: Repts. VI, Pt. I, p. 87; XI, p. 380; XII, p. 241; XIII, p. 341.

Owens Mine. Situated in the Julian district, in section 31, T. 12 S., R. 4 E., S. B. B. and M. Three veins in mica schist from 3 to 6 feet wide. Strike N. 70° W., dip NE. Shaft 350 feet deep. Ten-stamp

mill. Three men employed. Property being reopened by H. A. Williams of Julian, owner.

Bibl.: Repts. VI, pp. 85-87; VIII, p. 519; IX, p. 144; X, p. 541; XII, p. 242; XIII, p. 343.

GRAPHITE.

Liebuck Graphite Mine. It is situated in Mason Valley, 3 miles east of Oriflamme Creek, about 2 miles east of Mason. Elevation 2600 feet. The deposit is a band of graphitic schist with a maximum width of 80 feet, which is traceable for about 400 feet. At the south end of its exposure the schist strikes about N. 85° W. Farther northwest the strike shifts to N. 60° W. Average dip is 65 degrees NE. Graphite flakes are less than 0.2 millimeter, stated to carry 11.9% graphite. Owners, Frank Stevens of Julian, T. L. Works of San Diego.

Seyer Graphite Mine. It is 4 miles east of Mason, in section 34, T. 13 S., R. 5 E. Deposit occurs as two graphite bands of schist 4 to 12 feet wide. Most of the graphite forms minute flakes, a small fraction of a millimeter across a fine-grained schist, but scattered through the schist are rounded nodules of graphite as large as a pea. The graphite schist, according to reports, showed 16.2% graphite. Owner, W. B. Seyer of Julian, California.

LIMESTONE AND MARBLE.

In San Diego County crystalline limestone occurs at many points, in areas of metamorphic rocks, but owing to lack of transportation in the regions where it occurs, there has been very little development work done on these deposits.

Bibl.: Rept. XIV, pp. 673-674.

LITHIA MINERALS.

American Lithia and Chemical Company, 206 Broadway, New York City; Wm. N. Crane, president; Theo Ludlum, secretary. This company owns a large deposit of lepidolite near Pala, estimated tonnage being from 500,000 to 1,000,000 tons. Has been shipping ten cars per month of lepidolite to Wheeling, West Virginia, for use in the manufacture of glass. The ore is hauled from Pala to Oceanside, a station on the Santa Fe Railroad, a distance of 25 miles. Ten men are employed.

For description of the lepidolite deposits of San Diego County see Report XIV, pp. 706-708.

MINERAL PAINT.

See Report XV, pp. 689-690.

MINERAL SPRINGS.

There are a large number of mineral springs in the county, some of them having a high reputation as curative agents.

For a description of the principal springs, see Report XIV, pp. 717-722.

MOLYBDENUM.

Molybdenite has been found at several points in San Diego County. It occurs disseminated in flakes and small masses in a micaless granite or aplite, which appears to be dikes in the surrounding biotite granite. The principal deposits are situated 7 miles northwest of Ramona, also the occurrence is noted at several points between Campo and Julian. During 1916-1917 there was much activity shown in development of these deposits on account of the increased market value of the metal caused by the European war.

At present writing none of the deposits are being worked.

Aiken Molybdenum Deposit. The deposit is on ridge west of Campo, in section 9, T. 18 S., R. 5 E. Elevation 2650 feet. Molybdenite occurs disseminated in flakes and small masses in aplite dike, which strikes N. 30° W. This dike in the biotite granite is about 25 to 50 feet wide, and can be traced for a distance of ½ mile. The occurrence of molybdenite is small and very sparsely scattered through the aplite dike. The ore was first discovered in the railroad cut west of Campo. Owner, Edward T. Aiken of Campo, California.

Bour Molybdenum Deposit. This is the most important deposit in the county, and upon which the most development work has been done. The deposit is 6 miles west of Ramona, in section 3, T. 13 S., R. 1 W., on the south edge of San Pasqual Valley.

Molybdenite occurs in flakes and small masses in a micaless granite or aplite, which appears to be a dike in the surrounding biotite granite. The prospect work has been confined to the surface along the dike, and at several different points with open cuts. The molybdenum minerals occur in a zone 30 feet in width. Two well-defined shoots of ore have been developed by open cuts about 100 feet in length and 15 feet deep on the crest of the hill. At an elevation of 1350 feet, a crosscut tunnel is being driven SW. 240 feet to cut the dike at a depth of 200 feet below outcrop. The ore milled from the large open cut on top of hill gave an average of ½ to 1% molybdenum sulphide. The dike trends northwest, and has been traced 1500 feet southward from the brink of the gorge of the Santa Maria Creek, on whose south wall it is exposed. Its width varies from 30 to about 200 feet. The molybdenite is very unevenly distributed through the rock. The greater part of the dike is barren or nearly so, but the mineral is conspicuous in the open cuts lying between the road and the top of the hill to the south. The molybdenite is clearly an original constituent of the aplite to which it is confined. Its occurrence in the coarser parts of the rocks indicates that the coarse crystallization were both due to local concentration in the magma of the more mobile constituents. The dike as so far proven is for the most part barren, and its tenor as a whole cannot exceed a small fraction of 1%. A 25-ton mill was installed on the property, and one ton of concentrates were produced in 1917, which carried 60% Mo S_3. Milling operations were unsuccessful, and work was suspended the latter part of 1917. Owner, Mrs. E. M. Bour, 118 Harrison avenue, San Diego, California.

Harvey Ranch Deposit. It is situated in section 19, T. 15 S., R. 2 E., 11 miles east of Lakeside. Small specks of molybdenite occur in an aplite dike through a zone of 130 feet in width. Dike strikes N. 20° W. The greater part of the dike is barren, or nearly so, and the molybdenite was very much scattered through the dike in small flakes. T. J. Harvey of Lakeside, California, owner.

Judson Ranch Deposit. It is situated 5 miles west of Ramona, in sections 1 and 12, T. 13 S., R. 1 W., and is one mile northwest of the Bour mine. The deposit occurs in an aplite dike in the surrounding biotite granite, striking east and west, with a dip south. The dike has a width of 50 to 100 feet. At an elevation of 1900 feet an open cut has been made on the footwall side of the dike. The open cut is 100 feet long by 15 feet wide, with a depth of 10 feet, showing molybdenite sparsely disseminated through the dike in small masses or flakes. At certain points in the dike the molybdenite occurs associated with iron pyrites. Besides this open cut, the prospect work has exposed the rock at several points and the molybdenite occurs in a zone 20 feet or more in width. As at the Bour mine, the molybdenum is very unevenly distributed, the greater part of the rock being barren. The aplite dike can be traced from the gorge at the edge of San Pasqual Valley for a distance of one mile on the property. Owner, Andrew B. Judson of San Pasqual Valley.

Mayer's Ranch Deposit. A deposit of molybdenite occurs on the north side of Cottonwood Creek, 4 miles southeast of Dulzura. Undeveloped.

Sutherland Ranch Molybdenite Deposit. The deposit is about 7 miles from Ramona on the Julian Road. Molybdenite occurs in quartz veins from 1″ to 5″ wide. Owner, R. L. Case, Escondido, California.

Woolsey Molybdenite Deposit. It is 8 miles southwest of Ramona and ½ mile southeast of Sandy Dell Ranch, on highway to San Diego. Deposit consists of 40 acres of molybdenum-bearing ground. Northeast of the road where the highway cuts across the property, there is a showing of molybdenite in biotite granite. A series of open cuts have been made at different points north of the road, in the biotite granite, all of which show molybdenite in flakes and masses distributed through the granite. There is no well-defined aplite dike on the property, but in places the biotite granite is altered to aplite. Owner, Miss Ida Woolsey, San Diego, California.

NICKEL.

Friday Mine. It is situated 4 miles south of Julian, in SW. ¼ of SW. ¼ of section 15, T. 13 S., R. 4 E.

On the surface the outcrop of the vein is an iron gossan consisting chiefly of limonite striking east and west, with a width of 25 to 50 feet, which iron cropping can be traced ¼ mile west to Gibson property on section 16. In the upper workings of the Friday mine copper sulphide and carbonates with small amounts of nickel were exposed. The ore body has been developed by a vertical shaft which is in the gossan for 60 feet. The shaft is vertical for a depth of 130 feet. From this depth

the shaft has been sunk on an incline of 70 degrees for a distance of 45 feet. At 130 feet from collar, a drift has been driven east 108 feet. At a point 40 feet east of shaft the drift encountered the ore body, from which point the drift is in ore for a distance of 60 feet to where the ore body is cut off by a slip.

The ore body does not appear to be sharply defined, except where there is an indication that it is faulted. It lies near the contact of gabbro and schist, and in places is enclosed in gabbro. The ore body developed is 60 feet long and 20 feet wide. On the 175-foot level drift has been driven east in the schist 108 feet, at which point a crosscut was driven north, cutting a small lens of ore. The 175-foot level follows a zone of fissuring in the schist, and has failed to develop the ore body encountered on the 130-foot level. Ore consists mainly of pyrrhotite, but contains pyrite, and an iron nickel sulphide, and is accompanied by small quantities of amphibole and calcite.

Analysis of ore made by Dearborn Chemical Company, Chicago, Illinois:

Silica Si O_2	4.80%
Iron Fe	38.65%
Nickel-Ni	4.34%
Cobalt Co	2.37%
Arsenic As	5.95%
Sulphur S.	35.49%
Copper Cu	Trace

Assays of picked ore have carried as high as 22% nickle. Property idle. Owner, Friday Copper Mining Company, Frank Brown, president; Becker Stern, secretary; American National Bank Building, San Diego, California.

Bibl: Report XIV, pp. 666-667. U. S. G. S. Bull. 640 D.

PETROLEUM.

Petroleum of commercial interest has not yet been discovered in this county, although a number of wells have been drilled, and are being drilled, and the operators of these seem quite hopeful of success. In several wells small amounts of gas have been encountered and occasional layers of sandy material with small indications of oil, but nowhere has oil been encountered in measurable quantity. It is of interest to note that the middle miocene beds which are the chief reservoirs of oil in San Joaquin Valley and in Orange County, have not been identified in the county, and the deepest wells in the latter have passed through all the Tertiary beds and the cretaceous strata, and have penetrated a black shale, sometimes calcareous, which is probably of the Jurassic age. It is evident, therefore, that if oil be found, it must occur in beds of different geologic horizon from those constituting the commercial oil reservoirs to the northward.[1] The chief encouragement to drill for oil in western San Diego County is stated to be the frequent occurrence on the beaches of masses of asphaltic residue or brea.

During the year 1920 there has been a renewal of interest of the development of oil in San Diego County, and large number of com-

[1] Ralph Arnold. Bulletin Am. Inst. Min. Eng., March, 1914, pp. 406-11.

panies have been organized to drill for oil. Oil development at present writing consists of 5 wells being drilled by various companies, and as yet no oil indications have been encountered.

The following information relative to the different wells drilled is taken from the reports of the Department of Petroleum and Gas of the California State Mining Bureau:

Well No. "Balboa" 1. Balboa Oil Company, situated in lot 1105, T. 16 S., R. 3 W. Depth of well 5625 feet. Results being no oil or gas encountered. Well abandoned.

Community Oil Well No. 1. Community Oil Company, 377 Spreckels Building, San Diego, California. This well was known as Scott well and was abandoned 4 years ago, the present company taking over the well with the idea of drilling to a greater depth. Well located in section 9, T. 19 S., R. 2 W. Depth 1860 feet. Reported that oil sands were encountered. Well abandoned by company, and casing found in bad shape.

Community Oil Well No. 2. Community Oil Company, 377 Spreckels Building, San Diego, California. Well situated in section 4, T. 19 S., R. 2 W. A test hole was put down by the company to depth of 119 feet with Shattuck rig. Then the well was mudded up and abandoned.

Community Well No. 4. Community Oil Company, 377 Spreckels Building, San Diego, California. Well situated at Moreno, T. 16 S., R. 3 W. This well was drilled to a depth of 2112 feet, and struck substantial flow of water, and was considered by the company as a water well and abandoned.

La Costa Well, formerly known as Clark well, at La Costa Station, in section 26, T. 12 S., R. 4 W. Well being deepened by the La Costa Oil Company. Office 336 E street, San Diego, Cal. Original depth of well was 2330 feet, present depth 2190 feet. Reported a small showing of oil and gas. It is proposed to drill well to depth of 3000 feet.

Linda Vista Well, Linda Vista Oil Company, San Diego, California. Well situated in section 22, T. 15 S., R. 3 W. Depth 1095 feet. No oil or gas encountered. Propose to drill to depth of 3000 feet.

Ocean Side Oil and Gas Company is drilling a well in section 24, T. 11 S., R. 5 W. near Oceanside. Depth of well is 1450 feet. No oil or gas showing at present depth.

Otay Oil Company well is located T. 18 S., R. 1 W., near Otay. Depth of well reported to be 3500 feet deep. No oil or gas was encountered.

Tecolate Dome Oil Company, 331 Spreckels Building, San Diego. Are drilling well No. 1 in lot 1272, T. 16 S., R. 3 W. Depth of well 1050 feet. No indications of gas or oil reported at this depth.

Bibl.: Report XIV, pp. 708-710.

STONE INDUSTRY.

Granite occurs in this county in great variety and abundance, and is of fine quality for building and monumental material.

Simpson-Pirnie Granite Company, San Diego, are operating their quarry near Santee Station on the San Diego and Arizona Railroad.

The Simpson-Pirnie Granite Company's Quarry 1½ miles west of Foster, has been recently taken over by the Raymond Granite Company, who propose to operate the quarry on a large scale.

For complete detailed description on granite deposits see Report XIV, pages 671-676.

CRUSHED STONE AND SAND.

Independent Stone Company, 713 American National Bank Building, G. L. Parker, president; L. J. Rice, secretary, operating stone quarry at Spring Valley.

San Diego Stone Company, 643 Spreckels Building, E. A. Hornbeck, president; C. Kalbough, secretary, operating quarry at Sweetwater Dam.

Fenton-Sumption and Barnes Company, 168 Tenth street. Company produces gravel and sand from Otay Valley and Tia Juana Valley.

GRINDING MILL PEBBLES.

At several points along the ocean shore from Encinitas south to near San Diego, there are beaches of washed pebbles varying from 1 inch to six inches in diameter, which came from conglomerate beds made up of well rounded water-worn pebbles of various granitic and porphyritic rocks with some felsite and flint. The wave action has broken down portions of the cliffs for considerable distances and formed beaches of pebbles which are well washed and cleaned of softer materials. The rock sorted out for shipment are mainly basalt and diabase with an occasional felsite and flint pebble. J. T. Momand of Carlsbad is at present writing the only shipper of pebbles, which are collected on the beaches and hauled to Carlsbad, a station on the Santa Fe, where loaded in gondola cars for shipment.

SALT.

There is no source of salt in San Diego County, except the water of the Pacific Ocean, from which it has been extracted at various points on the coast by solar evaporation. At the present time there are but two plants in operation in the county, both of them near San Diego. They are operated by the Western Salt Company, and J. P. Duncan's Sons.

The **Western Salt Company's plant** is situated in the south end of San Diego Bay, near Fairchild on the San Diego and Arizona Railroad. Present production 12,000 tons year. For full description see Report XIV, pages 713-716.

The **Chollas Valley Salt Company,** controlled by J. P. Duncan, 1420 National avenue, San Diego, has a small plant. Its production amounts to 600 tons yearly.

Bibl.: Rept. XIV, p. 716.

SAN LUIS OBISPO COUNTY.

Since the Fifteenth Report of the State Mineralogist was published the only activity in mining has been in the production of the following minerals: Chromite, manganese, petroleum, quicksilver and sodium sulphate.

In the years 1917 and 1918, there was a great activity in the development and mining of chromite, manganese and quicksilver ores throughout the county, and the mineral wealth of the county was considerably increased during these years, but with the decline in metal prices following the signing of the armistice between the Allied Powers and Germany, practically all the mines were forced to suspend operations. A small amount of chromite and manganese is being mined in the neighborhood of San Luis Obispo to supply the local demand on the Pacific Coast.

When mining of chromite was active a number of concentration plants were installed on the different properties to treat the low grade ores; these plants are now idle. For detailed description of the different chromite and manganese mines see State Mining Bureau Bulletin No. 76, "Manganese and Chromium."

MINERAL RESOURCES.

Among San Luis Obispo County's mineral resources both developed and undeveloped are: Asphalt, bituminous rock, brick, chromite, coal, copper, gypsum, infusorial earth, iron, limestone, marble, mineral water, onyx, petroleum, quicksilver and miscellaneous stone.

Bibl.: Rept. XV, pp. 674-726.

BITUMINOUS SANDSTONE.

Sands of the Pismo and Santa Margarita formations which have been saturated with and cemented together by natural asphalt are of widespread occurrence in San Luis Obispo County. The deposits have been most extensively developed near Edna, a station on the Southern Pacific Railroad about 6 miles south of San Luis Obispo.

Bibl.: Rept. XV, pp 677-679.

The **Consolidated Bituminous Rock Company,** Nevada Bank Building, San Francisco, operated their quarry, one mile southwest of Edna, at irregular intervals during the year. Three to five men are employed.

PETROLEUM.

The only productive oil field in San Luis Obispo County is what is known as the Arroyo Grande field. This field, which includes Arroyo Grande, Edna, and Huasna districts is located south and southeast of San Luis Obispo. They include the area south of San Luis Valley drained by the San Luis Obispo and Pismo Creeks together with the drainage basins of the Arroyo Grande Creek and Huasna River. San Luis Obispo County produced in 1919 a total of 31,656 bbls., valued at $32,922.

The geology of the various oil districts and the present oil development throughout the county are described in detail in "Summary of Operations California Oil Fields of the Sixth Annual Report of the State Oil and Gas Supervisor, issued by California State Mining Bureau." Also in Bulletin 69, "The Petroleum Industry of California," so that no further description will be given here.

Bibl.: Bulletins 11, 19, 32, 63, 69; Annual Reports of State Oil and Gas Supervisor I, II, III, IV, V, VI.

QUICKSILVER.

The only activity in mining of quicksilver ores is at the following properties:

Klau Mine, 16 miles west of Paso Robles, California. The mine was reopened in the early part of 1920 by Carson Quicksilver Mining Company, G. B. Street, president; C. Underwood, secretary; offices.

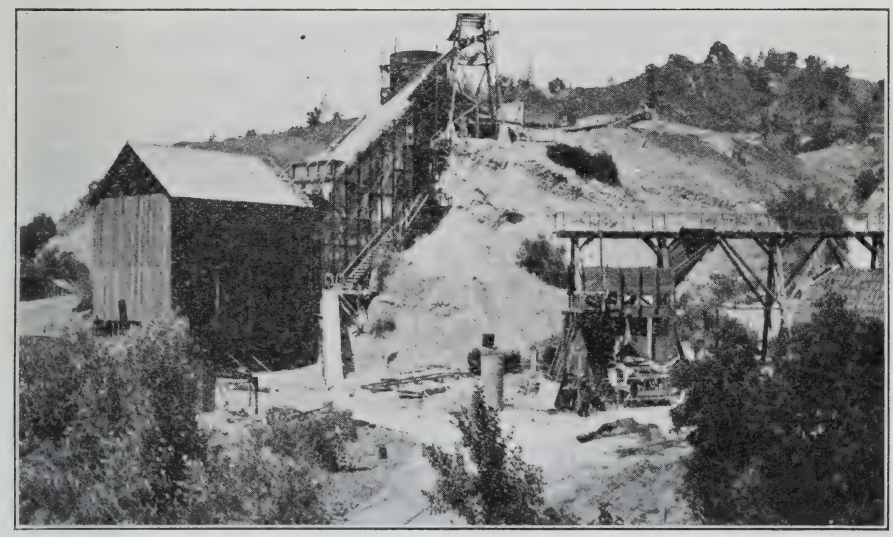


Photo No. 47. View of Fifty-Ton Scott Furnace, Klau Mine. Carson Quicksilver Mining Company, Klau, San Luis Obispo County.

Wilmington, Delaware; Ellard Carson, general manager. A new 50-ton Scott furnace has been installed, and was placed in operation on September 1. Thirty-five men are employed.

Bibl: State Mining Bureau Bulletin No. 78, pages 135-138, "Quicksilver Resources of California."

Oceanic Mine, 5 miles east of Cambria, Murray Innes, owner, 217 Kohl Building, San Francisco; Ellard W. Carson, manager, Cambria. Operating one 50-ton Scott furnace, producing 100 flasks of quicksilver per month. Fifty men employed. For detailed description see State Mining Bureau Bulletin No. 78, pages 140-141, "Quicksilver Resources of California."

Rinconada Quicksilver Mine, situated 11 miles east of Santa Margarita, operated by Rinconada Mercury Corporation, George Hathaway, president, Chas. R. Hamilton, secretary; A. H. Simpson, superintendent; offices at Margarita, California. The company is installing a 75-ton rotary furnace on the property. Twenty men employed. For detailed description of mine, see Bulletin No. 78, pages 147-148, "Quicksilver Resources of California."

SODIUM SULPHATE.

Soda Lake lies in Carrizo Plain, T. 31 S., R. 20 and 21 E. It contains 3000 acres, practically all of which have been located by the Consolidated Chemical Company, which has 23 claims. The lake receives the drainage of the Carrizo Plain. The salts leached out by the rain water have formed a layer, usually very thin, but in places filling deeper channels. Under this crust is a mud layer containing considerable of the salines in solution. The deposit is principally sodium sulphate, but crystals of blödite, the hydrous sulphate of magnesium and sodium, are associated with it.

Due to the increased demand at present for natural sodium sulphate, the deposit is being extensively developed by the Consolidated Chemical Company of Lompoc, California. The company has a plant at Soda Lake for evaporating the saline water and recovering the solid salt. Capacity, 600 tons per month. The deposit can be easily mined, although the long haul of 28 miles to McKittrick, the nearest shipping point, makes the marketing of the product by the company a difficult problem. The amount of salines available have been estimated at over one million tons.

Bibl: Rept. VIII, p. 532; X, p. 563; XV, p. 127. Bull. 24, p. 136. U. S. G. S. Bull. 280, p. 369; Bull. 540, p. 428.

SANTA BARBARA COUNTY.

Santa Barbara County owes its principal mineral output to the presence of productive oil fields within its boundaries. Outside of oil development there has been very little activity in mining and development of other minerals contained in the county during the past year.

Therefore only brief mention will be made of the properties that were producers since the Fifteenth Report of the State Mineralogist was issued. The reader is referred to this report for detailed description of the different mineral deposits.

MINERAL RESOURCES.

Santa Barbara contains asphalt, chromite, diatomaceous earth, gilsonite, gypsum, limestone, magnesite, mineral water, natural gas, petroleum, potash, quicksilver and miscellaneous stone.

Bibl: Rept. XV, pp. 727-750.

ASPHALT AND BITUMINOUS ROCK.

There are many deposits of asphalt and bituminous rock in the county, only one of which is worked. The **Higgins Mine**, owned by Higgins Estate, is one mile southeast of Carpinteria Station, between the railroad and the sea. Beds of bituminous sandstone occur on the property, widths varying from 12′ to 20′ underlying the shales that trend towards the sea. A small production was made from the mine during the past year, for use on the roads in the county. Property is worked under lease.

Bibl: Rept. XV, pp. 730-734.

BRICK.

The **Coleman Brick and Lime Company,** Santa Barbara, W. T. Coleman, owner, operated their brick kilns during the past year. capacity of kilns being 40,000 bricks daily. Sixteen men are employed

Bibl: Bull. 38, p. 257, Rept. XV, p. 735.

CHROMITE.

Since the Fifteenth Report was issued a number of deposits of chromite were developed, one of which shipped some ore in the latter part of 1918.

La Laguna Ranch Chrome Deposit. It is situated 12 miles northeast of Los Olivos in the San Rafael Mountains, on ridge between Figueroa and Coralles creeks. Lenses of chromite occur in a belt of serpentine on the southeast slope of the ridge. Chromite occurs in massive boulders, and a large amount of float is scattered along the ridge and in the different gulches. Burns and O'Donnell of San Francisco opened up and developed these deposits under lease, and also discovered some deposits of greater extent on adjoining government land in township 8 N., R. 30 W. Owner, La Laguna Ranch Company,

W. H. Bradley, secretary, 320 Chamber of Commerce Building, Pasadena, California.

Los Olivos Chromite Deposit. A deposit of chromite occurs 16 miles east of Los Olivos, in the San Rafael Mountain Range, $\frac{1}{4}$ mile north of Happy Cañon and Acachuma wagon road. The chromite occurs in small lenses in a wide belt of serpentine which strikes northwest and southeast. Owner, P. B. Montanaro of Los Olivos, California.

DIATOMACEOUS EARTH.

Celite Products Company, formerly the **Keiselguhr Company of America,** home office 11 Broadway, New York City; local office 1135 Van Nuys Building, Los Angeles, California; A. H. Krieger, general manager. The company owns valuable and extensive deposits of infusorial earth, 2 miles southeast of Lompoc. The company has been a larger shipper of this material during the past two years. The capacity of the plant has been increased, and a kiln installed for the manufacture of celite brick. The deposit occurs in extensive beds of soft, white earth in a very pure state, varying from thinly bedded to massive, forming a capping over the hills, overlying brown siliceous shales, conformable with them, striking east and west, and dipping 30 degrees south. The material is quarried in open cuts. It is taken up in large blocks, air dried at the quarry. It is then hauled by trucks to the plant at Lompoc, where it is ground to powder and transferred to different warehouses by a pneumatic system. When blocks of the material are required, the material is transported in its natural state direct from the quarry, sawed into required sizes and dried before shipment. The waste material too fine to be dried is utilized in making brick, tile and other refractory materials. One hundred men are employed.

Bibl.: Bull. 38, pp. 293-296. Rept. XV, pp. 737-738.

Salispuedes Ranch Deposit, owned by the Hollister Estate, Santa Barbara. The deposit is over 100 feet thick and very extensive, capping low hills south of the Santa Ynez River, and 3 miles southeast of Lompoc. Property under lease and bond to the Diatomite Products Company, A. E. Cohen, president, who propose to develop and operate the property on a large scale.

Bibl.: Bull. 38, p. 296, Rept. XV, p. 738.

LIMESTONE.

Union Sugar Company, Betteravia, operates a limestone quarry, 6 miles southwest of Lompoc, on the north side of San Miguelito Cañon. The limestone occurs in a massive ledge varying in width from 15′ to 35′. Operated continuously. Product shipped to the company's sugar plant at Betteravia. Twelve men are employed.

Bibl.: Rept. XV, pp. 739–741.

PETROLEUM.

The production of petroleum for Santa Barbara County for the year 1919 was 6,089,082 bbls., valued at $6,850,217, while the production of natural gas amounted to 4,084,709 M. cu. ft., valued at $336,092. The

producing oil districts of the county are: Santa Maria, Lompoc, and Summerland fields. A detailed description of these fields is contained in Bulletin 69, "The Petroleum Industry of California," also recent information on oil field development in the county is contained in the Annual Reports I, II, III, IV, V, VI of the State Oil and Gas Supervisor, issued by the State Mining Bureau. Therefore no further description will be entered into here.

Bibl.: Repts. VII, p. 89; XII, p. 537; XIII, p. 582 Bulls. 11, 19, 32, 63, 69.

QUICKSILVER.

Acachuma Mine. It is situated in section 2, T. 7 N., R. 29 W., 12 miles east of Los Olivos at the head of the Acachuma Creek. Developments consist of several tunnels totaling 2000 feet. Has been worked during the past year by C. Wood of Los Olivos, owner.

Bibl.: Bull. 27, p. 196. Rept. XV, p. 746.

Los Prietos Mines are 8 miles in an air line directly north of Santa Barbara, in that portion of the Santa Ynez Mountains north of the river. This group of mines, known as the Snow and McAvoy-Millburn mines, was purchased in 1918 by F. M. Townsend and associates of 912 Higgins Building, Los Angeles. A large amount of development has been done on the two properties since Report XV was issued, and some experimental work done on the ores extracted with the idea of installing a rotary furnace at the Snow mine. There is a 12-pipe retort on the property. C. L. Millburn of Los Angeles, superintendent.

VENTURA COUNTY.

Ventura County was the tenth county in the state in respect to the value of its mineral production for 1919, the exact figure being $3,017,074, practically all of which was due to the output of petroleum and natural gas, the remainder being made up of clay, clay products and miscellaneous stone.

Among its other mineral resources are: Asphalt, borax, gypsum, mineral water, phosphates, sandstone and miscellaneous stone.

Since Report XV was issued there has been practically no developments of other mineral resources of the county.

For detailed descriptions of the mineral deposits of the county, see Report XV, pp. 751–769.

Brief mention will be here made in regard to petroleum:

Ventura County increased its production of oil, for the year 1919, to 1,685,073 bbls., valued at $2,755,094, the output of natural gas being 1,038,574 M. cu. ft., valued at $252,240. The highest gravity of petroleum produced in the state is found in the county.

The producing oil fields of Ventura County are confined to the Santa Clara Valley and the hills north of the Simi Valley. The principal oil fields are Newhall, Ventura-Ojai and Santa Paula-Sespe.

As the petroleum industry in this county is described in detail in Bulletin No. 69: "The Petroleum Industry of California" and also in the Annual Reports of the State Oil and Gas Supervisor, issued by the California State Mining Bureau, no detailed description will be entered into here.

Bibl.: Repts. VII, p. 101; VIII, p. 684; XII, p. 357; XIII, p. 585. Bulls. 11, 19, 32, 63 and 69. Annual Reports of State Oil and Gas Supervisor, 1, 2, 3, 4, 5 and 6.

AUBURN FIELD DIVISION.

Part I.

By C. A. Logan.

INTRODUCTORY.

The counties of Plumas, Sierra, Nevada, Butte, Yuba, Placer, El Dorado, Amador, Alpine, Calaveras and Tuolumne are included in the Auburn or Central California Field Division.

The district (with the exception of Alpine County) slopes westward from the summits of the Sierra Nevada to the valley floor, which has an elevation of 30 feet above sea level at Sacramento. Going eastward from Sacramento on the overland route of the Southern Pacific Railroad, the upward grade is encountered first at Rocklin, and continues steadily till the summit is crossed at an elevation of 7018 feet, and 104 miles east of Sacramento. The pass through which the Western Pacific Railway enters the state is much lower, following as it does the course of Feather River, but a profile elsewhere across the district from west to east shows the same upward grade, culminating in passes from 6300 to 9600 feet in elevation, through which scenic highways lead into Nevada. Eight such main automobile roads cross the mountains and these are all heavily travelled in summer. The westward slope is traversed by numerous rivers which drain into the main trunk streams, the Sacramento and San Joaquin rivers. The tributaries have carved deep cañons, in many places 3000 feet below the old peneplain surface, and have had the effect of cutting the country into roughly defined blocks or "divides". The roughest and steepest grades occur where the roads cross from one divide to another. As the rivers approach the valley floor they break from their cañons, and, at the height of the rainy season, have in past years often caused floods in the valley farming districts, a condition partially remedied by flood control measures.

Fruit and grain raising are principal industries of the valley and adjacent foothills and deciduous fruit especially reaches its highest development in the decomposed granodiorite soil of the Placer County foothills wherever water for irrigation is available. The fruit belt ends at about 2500 feet elevation.

Besides being the principal gold placer and gold quartz mining district of the state, production of the following minerals and metals has been made on a commercial scale: Asbestos (chrysotile and amphibole), barite, brick-clay, building stones, coal (lignite), chromite, copper, fire-clay, glass sand, granite, iridium, iron, limestone, manganese, marble, mineral pigments, mineral water, osmiridium, platinum, pyrite, quartz, quartz crystals, silver, slate, soapstone, and tungsten. Most of these are now being produced and deposits of the others will no doubt ultimately be utilized again. There are also undeveloped prospects of lead, magnesite and molybdenum.

The dredgers, now the chief producers of placer gold here, are located on the lower courses of nearly all the rivers from the places where they leave their rocky cañons downstream as far as working is profitable. Hydraulic and drift mines formerly highly productive, contribute comparatively little now to production. Quartz mines, found in every county, may be grouped into several rather well defined belts of which the Mother Lode, East Belt, and Grass Valley and Nevada City districts are best known.

ROADS AND TRANSPORTATION FACILITIES.

Transportation is generally adequate and comparatively cheap, due to paved highways, good dirt roads and branch line railroads. The mines of Tuolumne County have railroad connection over the Sierra Railway of California, which meets the Southern Pacific at Oakdale and extends to Jamestown, Angels Camp, Sonora and Tuolumne. A good highway extends from Stockton to Sonora and good roads branching from it and radiating from Sonora, reach the Mother Lode mines and the districts around Soulsbyville, Confidence, Tuolumne, Columbia and others.

From Sonora a road goes past Tuttletown, Melones and Angels Camp. The latter district has a branch railroad and also an outlet by graded highway through San Andreas to a branch of the Southern Pacific at Valley Spring; the highway continues to Lodi, connecting with the state highway to Stockton and Sacramento. A good road runs from San Andreas to the adjoining county seat of Jackson, most important of the Mother Lode towns. Jackson has railroad and wagon road connection with Ione, where the Amador Central Railroad meets the Southern Pacific Company's branch from Galt. A good macadamized road extends north from Jackson along the Mother Lode through Sutter Creek, Amador City, Drytown and Plymouth. From Plymouth one may drive north along the Lode to Nashville, Placerville (on a Southern Pacific branch line) and may drive the entire length of Eldorado County, meeting a main line railroad at Auburn, or he may drive west to Sacramento. As the climate is mild at these low altitudes, most of these roads are traveled the year round.

Roads from Auburn and Colfax extend to all the mines of the Forest Hill and Iowa Hill divides and to the higher mountain country beyond Westville. Above 3000 feet elevation the roads are not as a rule passable for automobiles between the middle of November and the middle of April.

The state highway from Sacramento, paved as far as Auburn, is partly graded from Auburn to Grass Valley and is paved from Grass Valley to Nevada City. This road is used by automobiles the year round. From Nevada City to Washington there is a dirt road 18 miles long, open for automobiles from May to November. Similar dirt roads run from Nevada City to North Bloomfield, 15 miles, and Graniteville, 31 miles; to North Columbia, 15 miles; Alleghany, 32 miles, and Forest City, 36 miles. Branch roads and trails from these places reach the mines.

There are two routes from Nevada City to Downieville—one via Alleghany, the other and better via North San Juan and Camptonville, 46 miles. Part of the latter passing Indian Valley is graded highway. From Downieville the road follows Yuba River to Sierra City, then turns north to climb the mountains, passing the summit at Gold Lake and reaching the Western Pacific Railway at Blairsden. The trip up the Yuba Cañon and over the summit is equaled by few in scenic beauty.

Quincy and the Plumas County mines may be reached during the dry season by automobile from Marysville via La Porte, a distance of about 100 miles, or 65 miles drive from Oroville. The first road gives access to the famous old drift and hydraulic mines at La Porte, Port Wine,

Table Rock, Scales, Gibsonville, and Little Grass Valley, all in easy driving distance of La Porte. The second passes through Bucks Ranch, from which place the mines on and adjacent to the Middle Fork of Feather River may be reached. The copper mines near Indian Valley may be reached by machine from Quincy, or from any of the towns in Indian Valley. This district has also the Indian Valley Railroad, which connects with the Western Pacific Railway at Paxton and runs to Engels.

The hydraulic and drift mines of Butte County, most of which are idle, and the Oroville and adjacent dredging fields, now nearly worked out, are reached from Chico and Oroville. Likewise, roads to the mining districts of Yuba County radiate from Marysville.

Alpine County, consisting entirely of an elevated mountain region, is reached from the west via Auburn and Truckee or via Placerville to Meyers Station near Lake Tahoe, thence over the summit and down the West Carson Cañon; or through Jackson and Kirkwoods; or through Angels Camp, Calaveras Big Trees, and Hermit Valley (8900 feet elevation at summit), thence down the East Carson River to Markleeville. This county has a very small permanent population.

POWER AND WATER SUPPLY.

The mines and dredgers of the district are operated by hydro-electric power, except in the case of small isolated properties and prospects, which use steam or water. The Great Western Power Company utilizes the water of the Feather River watershed, and the Pacific Gas and Electric Company that of rivers to the south, including the Yuba, Bear and American. Lake Almanor and Lake Spaulding are immense storage reservoirs, which regulate the flow to the power houses during the summer. The streams of the district still possess enormous undeveloped power possibilities and new developments are constantly going on. This latent and inexhaustible resource is one of the state's chief assets. Electricity should eventually displace at a lower price all other forms of power, light and heat in central California.

The water supply in the region fluctuates seriously because of the division of the year into wet and dry seasons. The need of water for irrigation has outstripped the development of storage facilities, so that in dry seasons following winters of light snowfall in the higher mountains, a shortage of water for irrigation, placer mining, and electric power generation arises. Disputes follow both as to priority of right to the running water, and the right to the use of the electric power generated from it. The miner feels, and justly so, that his business is as important and essential to public welfare as any, and rightly resents an "apportionment" of power which permits nonessential uses of electricity in cities, while stamp mills, hoisting works and dredgers are permitted to work only part time. The mining industry suffers in this particular as in others, because of a lack of voting strength and solidarity. Local conditions and lack of capital to build ditches and reservoirs result in a short productive season for many of the hydraulic and drift mines. In the higher mountains many mines can wash gravel only during the spring thaw.

CLIMATE.

The climate below an elevation of 3000 feet is ideal for mining. Snow seldom occurs, and does not lie long on the ground, below the 2500-ft. contour. The mines of the Mother Lode, the dredging fields, the foothill copper belt (except Plumas County) and many others are in a belt where spring begins in February. The temperature in summer goes rarely to 110 degrees Fahrenheit in the lower foothills in the middle of the day, but the almost total absence of moisture in the air makes this temperature safe and prostrations from heat are practically unknown. The winter temperature in this foothill region seldom goes below 25 degrees and practically never below 14 degrees, which low point may be reached once in the winter.

The mountains from 4000 feet elevation upward may be snow-covered from about November 15 to April 15. From May to November the climate in the mountains is ideal, with days of unbroken sunshine and dry air, and cool nights. The western slope of the mountains has the same long dry season as the valley, but on the east or Nevada side of the summit there are occasional summer thunderstorms.

LABOR.

In the placer mines native American labor is used, but in the large quartz mines there is a great variety of races, and some of these have taken hold so firmly as to give certain camps a well-marked individuality, where the few American miners, if any are hardy enough to remain, seem almost foreigners. During the good times when mining on the Mother Lode was active, it was no uncommon thing to find underground crews of 200 to 250 men in which only 5 or 6 were American-born. With the decadence of mining in recent years, the population of the mountain districts is falling off rapidly.

OUTFITTING AND SUPPLY POINTS.

Each county seat is usually a district center and supply point. This is the natural outgrowth of early conditions. In every case the county seat was in the beginning one of the first and most important of the mining camps. All miners' trails led that way, and when trails became roads the county seat was found to be the center of the system. There is usually the place to gather preliminary information, and there one must go to search records.

Besides well stocked general merchandise and hardware stores found in all the county seats, many of the mining towns have foundries. At Grass Valley the Taylor Foundry and Engineering Company makes general mining machinery; at Nevada City the Miners Foundry; at Angels Camp (Altaville) the Angels Iron Works; at Sutter Creek, the Knight Company. All have been established for years, and many of the largest stamp mill installations and hoists in California have been made by them. At Marysville, the Yuba Construction Company makes all kinds of gold dredging machinery, and also tractors, and their products go to all parts of the world.

Part II.

Auburn District: By Counties.

ALPINE COUNTY.

The mineral industry of this county has been quiet for a good many years. The county at an early date was a notable producer of gold, silver and copper, mining having begun in the early sixties. This county lies entirely along the summits and east slope of the Sierra Nevada Mountains and the easiest way to reach the district is through Reno, thence over the Virginia and Truckee Railroad to Minden, and from there by auto stage to Markleeville. Four good dirt roads make the automobile trip in summer from the California side a pleasant and interesting one. (See under roads and transportation facilities.)

Photo No. 48. View of Markleeville, county seat of Alpine County. Photo by C. A. Logan.

Markleeville, the county seat, is practically the only town in the county and has a permanent population of probably about 150. It lies at an elevation of 5500 feet, in a district possessing great natural attractions for campers, and having mineral resources that have been only partially prospected and developed.

The known mines are all situated above 6000 feet. The region is isolated, and because of the character of the ores is not calculated to attract the average prospector. Geologically, the country differs entirely from the western slope of the mountains.

The following mining districts have received some notice in past publications: Monitor, Mogul, Silver Mountain, Silver King, Blue Lakes-Hope Valley joint district. Very little has been done in any of these districts except the first two, in the last thirty years. There is at present some prospecting during the summer in the Monitor, Mogul and Hope Valley districts on the old mines, and newer finds have been made near the state line below Woodfords and in the Wolf Creek district. The writer visited the county in August, 1920, and gathered information on the properties mentioned below, which are the only ones showing any recent activity.

The geology of the Mogul and Monitor districts is described by Eakle[1], who emphasizes the immense scale on which the volcanic rocks

[1] A. S. Eakle, Ph.D., Mines and Mineral Resources of Alpine County, California. State Mining Bureau, 1916.

of the region have been mineralized. The andesites have been altered and silicified by ascending hot solutions carrying the minerals forming the ores. The resulting mineral deposits are zones of rich, narrow stringers and impregnations of immense bodies of lower grade without definite walls.

Silver ore was first found at Silver Mountain in 1861 and ore was discovered at the Morning Star mine in 1863. Work began on the Advance mine at Monitor in 1863, and at the Tarsus, later called the Colorado No. 2, probably the same year. According to Peter Curtz, the first reduction plant in the county was a 10-stamp mill built in 1863 at Markleeville by Paul Pioda for custom work. This mill crushed about 1000 tons of ore from the I. X. L. mine in the Silver Mountain district

Photo No. 49. Monitor, Alpine County. All that is left of a camp that had over 2000 inhabitants in the '60's and '70's. Photo by C. A. Logan.

in 1864, and Mr. Curtz, who worked in the mill, states that this ore assayed $250 a ton of which about $125 a ton, or 50%, was recovered. The charge for milling was $30 a ton. Gold ores were also worked in this mill from the Boulder Hill and Washington mines.

The difficulty of treating the ores successfully has been a great setback to the mines in the county. Such was the history of Silver Mountain, the Exchequer and I. X. L., Globe, Advance and for a time the Colorado No. 2. Transportation to the railroad in the old days was also slow and very expensive.

There is ample water available in the forks of Carson River and in their perennial tributaries for generating electric power. The absence of good timber in the region near the river is striking. It was stated in 1868 that 5,000,000 feet of saw logs and 6000 cords of wood were being floated down the Carson River each year for the use of the Comstock mines in Nevada.

GOLD AND SILVER.

Advance Group adjoins the Colorado No. 2 and is below it on the slope of Colorado Hill near the old town of Monitor, which has disappeared except for two old hotel buildings. This group, consisting of seven locations, comprises the unpatented claims formerly held by the Hercules Consolidated Mining and Milling Company, which still retains the Colorado No. 2 and other patented ground.

The Advance (now **North Advance**) is opened by a tunnel driven north into Colorado Hill from near the level of Monitor Creek. At the face, the tunnel is 700 feet below the outcrop. At a distance of 660 feet from the portal the tunnel is forked, the right branch entering the patented ground of the Colorado No. 2, where it connects by winze with the upper workings of that property. The west branch continues N. 15° W.; 100 feet to the Du Boise stope, which is in the Advance ground. About 1912, Du Boise had a lease and option on the Hercules Consolidated holdings which then included the Advance and Colorado No. 2. During his one year's tenure, he opened the Du Boise stope and is said locally to have taken out several thousand dollars of ore, shipping the high grade and running the Colorado mill 3 or 4 months on low grade ore. This ore occurred in a bunch which opened out suddenly from a narrow stringer lead, which is associated with pink and black manganese minerals. Two of the owners were putting up a raise on a stringer of ore just off the Du Boise stope when visited. The ore stringers of complex sulphides run from ¼″ to 1″ wide, at times mixed with the manganese minerals and at times in the soft clayey seam filling of the altered rock. This stringer had been followed up 40 feet in the hope it might open into a chamber of ore. A small shipment made this summer is reported by the owners to have yielded 100 oz. silver and $20 gold a ton.

On this level there are probably 2500 feet of drifts and crosscuts, most of them in low grade ore, and there are several old stopes above the level. At the portal of the tunnel there is a caved shaft said to be 300 feet deep. This shaft was put down in the sixties or seventies and is supposed to have been in good ore which was too base to yield to methods of treatment used then. It has never been cleaned out since the mine was closed about 1880. There is no machinery or equipment on the property. Owners, A. M. Dahl, J. H. Pearson, and A. L. Stewart of Markleeville and G. P. Merrill of Woodfords, Alpine County.

Alpine Mine is now a part of the Curtz Consolidated. This property was worked to a depth of 200 feet, and is said to have produced $378,000 from two ore shoots, which were rich in free gold.

Colorado No. 2 is owned by Hercules Consolidated Mining and Milling Company, Reno, Nevada. No recent work has been done on the Colorado No. 2, the last ore milled having come from the adjoining Advance. Recent exploration has been through the Advance tunnel, which is about 100 feet vertically below the lower tunnel of the Colorado No. 2; the Advance Tunnel is no longer owned by this company, and the upper tunnels formerly used are said to be inaccessible. The Colorado mill is on these claims. It contains 20 stamps, 8 Frue

vanners, 1 Pindar, and 1 old Wilfley concentrator, an old double compressor, a steam plant and four large old style electric motors. The mine plant included electric locomotives, electric hoist, and a great deal of valuable equipment, which is ruined by exposure or has been carried off. There is also a power site on the East Carson River.

This mine was the principal silver producer of the county. It was worked from 1864 to 1876, and the concentrates were shipped out, as they could not be treated successfully at the mine. Was closed in 1876 and reopened by Peter Curtz in 1879. Curtz operated the property about one year, and the record of his operations are the only definite data at hand now about the property. He used the chlorination process at the property with good results, recovering in bullion from 91% to 95% of the assay value of the concentrates.

Concentrates treated during the summer of 1879 ranged in value from $420 to $900 a ton, averaging $584, of which from 38% to 43% was in gold and the balance silver. As the concentrate rose in value, the percentage of gold increased. The ore averaged about $12 a ton. The mill at that time contained 10 light stamps and 4 Frue vanners, but 5 stamps more were added during the season. Curtz states his mining and milling cost totaled $1.50 a ton.

The mill equipment was being removed from the property late in 1920.

Wolf Creek Group. This is a group of claims located in part in May, 1920, near the mouth of Wolf Creek, a tributary entering the East Fork of Carson River at a point about 4 miles from the old camp of Silver Creek. The district is reached by trail from the highway near Silver Creek. High grade gold ore was reported to have been found in float quartz here during the past summer, and the owners, Ed Dickson, J. P. Woodbury, R. T. Dickson, Geo. Smith, and E. T. Drake, were sinking prospect shafts. Elevation 6000 to 7000 ft. Located approximately in sections 20, 21, 22, T. 9 N., R. 21 E.

Woods Lake Mine. Work was done years ago on this property, which is reached by about a mile and a half of trail from the Amador road near Woods, and is in section 27, T. 10 N., R. 18 E., near the summit of the Sierras. Ore that carried 20% galena and was worth $80 a ton in gold, silver and lead, is said to have been mined from a winze near the mouth of one of the tunnels years ago, and packed out; but there is no definite record of this. The country rock is granite and mica schist. There are 8 claims in all. The vein was developed by two tunnels, one of them 100 ft. long.

W. G. Hoffman bonded the property in the summer of 1920 under an agreement to do $2500 work, and was prospecting it in August. R. S. Wray, B. Phillips, A. Lowe, Aug. F. Stiegeler (a jeweler of San Francisco), and W. G. Hoffman are the locators.

COPPER.

Alpine Fairview Group. Tri-State Mining and Development Company, Reno, Nevada. Eight claims in section 1, T. 11 N., R. 19 E. Superintendent, P. A. Sample, Gardnerville, Nevada. Claims are 7 miles from Woodfords, near Bazeman's Ranch, ¾ mile from the state line, and the same distance from the Woodfords-Gardnerville road, at an elevation of about 6500 feet. Eight years ago a 40-ft. tunnel was

driven and abandoned. Lately a shipment of a few tons of copper oxide ore from near the surface was made, and assays are said to have been very encouraging.

Curtz Consolidated Group. Curtz Consolidated Mining Company, Bank of Italy Building, Oakland, Peter Curtz, manager. There are 22 mining claims, a dam site and power plant on East Fork of Carson River. The mining ground includes the Alpine group covering 4500 feet on the Alpine outcrop, Georgia group of 5 claims, and the Morning Star group, covering 9000 feet on the outcrop of same name, all in section 29, T. 10 N., R. 21 E., in the Mogul district, and is reached by 8 miles of road from Markleeville. Eakle[1] has described the geology of the district, and the history of the property. No work except assess-

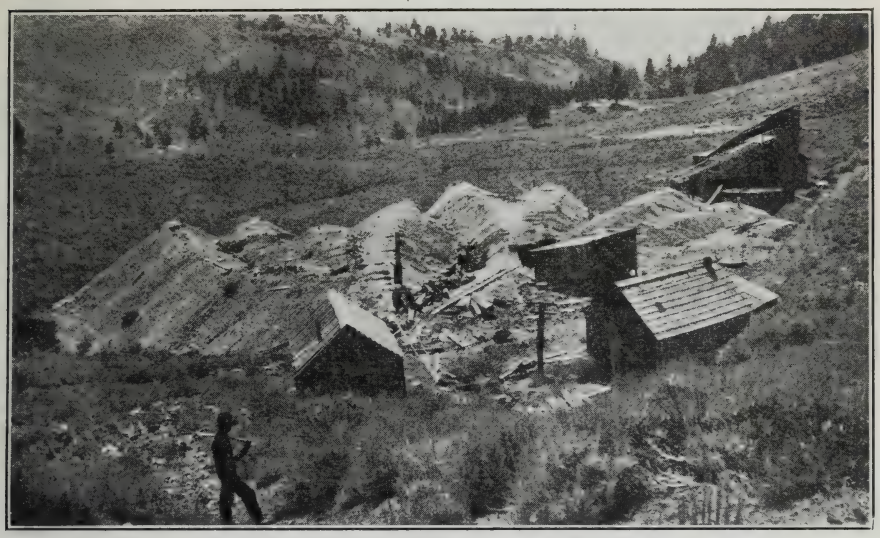


Photo No. 50. New mill and dumps at Curtz Consolidated property, Mogul District, Alpine County. Photo by C. A. Logan.

ment has been done since his report. The Morning Star mine is credited with a production of $600,000. The enargite ore shipped to Swansea during 2 or 3 seasons is said to have carried $400 a ton in copper, gold, and silver. About $100,000 of the production was from cement copper and amalgamation at the mine about 1882 when Louis Chalmers operated the property. There has been little, if any, production since then, as all the work in recent years has been aimed at developing the mine at greater depth than the old workings. The new tunnel driven by Curtz in 1914 was intended to strike the Morning Star ledge 800 feet in, but the dip of the ledge in its downward extension had probably changed to vertical, and it was not found. At a distance of 1000 ft. the tunnel encountered what Curtz called the West Ledge, which he says is 30 ft. wide with bunches and streaks of milling ore. He followed this ledge 100 ft. by a drift, and 600 ft. by a parallel drift and crosscuts. Sixty feet east of the West Ledge he crosscut the Silver Ledge, 10 ft. wide,

[1] A. S. Eakle, Ph.D., Mines and Mineral Resources of Alpine County, California. State Mining Bureau, 1916.

which he says averaged $12 a ton. This same ledge is reported to have been cut on the 190 level 300 ft. distant on the strike from the above mentioned crosscut. The ore in this body is thought to be amenable to concentration on the ground, judging by tests made by Curtz. He believes this ore body should be the first objective of any new work, as it can be quickly and easily reached. He reports some concentrates from it assayed $40 gold and $94.37 silver per ton.

The ores of this group of mines are numerous and complex, comprising enargite (arsenical copper ore) complex silver sulphides, auriferous pyrite, and small amounts of galena and zincblende. There is considerable pyrite on the old Morning Star dump which carries gold and shows the intimately mixed enargite. The more interesting and important workings of the mine are not accessible. Work was resumed on this property late in 1920.

Globe Mine. It is in Monitor district in the south ½ of section 31, T. 10 N., R. 21 E., 7 miles from Markleeville, most of the way by good road. This property was worked in the 60's and 70's by Colonel Winchester, a devout spiritualist. A crosscut adit was driven about 1000 ft. to the ledge and 200 to 300 feet of drifting was done. The mine produced some chalcocite ore carrying gold and silver, which was hauled by teams to Sacramento at a cost of $40 a ton for shipment to the coast. Attempts to treat the ore at the mine were unsuccessful.

After lying idle practically since those days, the mine was taken hold of in 1918 by J. O. W. Applegren, who has done some new crosscutting and drifting, and was reported to have a good prospect, but he was absent and the mine was idle in August, 1920. Resumption of work was planned.

LEAD.

Black Jack Lead Prospect. One unpatented claim lying about a mile and a half by trail from Loope, approximately in section 28, T. 11 N., R. 21 E. Lumps of high grade galena have been found in a clay seam and in masses on the surface, but no vein had been uncovered up to last August. A few shallow prospect holes, 50-ft. tunnel and 20-ft. crosscut had been driven up to that time.

MINERAL SPRINGS.

Grover's Hot Springs. This property is 4.2 miles by road from Markleeville. Two groups of hot springs issue from a terrace on the edge of a meadow 200 to 300 yards south of Markleeville Creek. The springs deposit a good deal of calcite, and the terrace has probably been built up in this way. The combined flow from the dozen springs is probably 12 miner's inches, and the temperature of the water ranges from 128° to 146° F., being in one case too hot to drink. Water from one group is collected in a small bathing pool. Local people and campers resort to the place a good deal in summer, and the water has a local reputation for benefiting colds, rheumatism, etc.

In October, 1920, a movement was on foot in Markleeville to obtain the springs and surrounding land, and make the place a free camp site and park for tourists. It is admirably fitted for such use, as the

location is one of great natural beauty. Following is an analysis of the water by Laird J. Stabeler:

Grains per U. S. gallon.

Na_2Cl	19.91	$CaCO_3$	6.38
Na_2SO_4	12.02	$MgCO_3$	1.16
Na_2CO_3	34.10	Fe,Al	0.32
Organic matter	Trace	Silica	0.82

There are other mineral springs in the county which are so remote that they are seldom visited.

AMADOR COUNTY.

Amador County, known principally for its deep gold quartz mines, also has valuable gold placers, lignite beds, pottery and fire clay and silica sand deposits and less important resources of chromite, copper, limestone, marble and sandstone.

The Mother Lode Belt extends through the county in a northwesterly and northerly direction and the principal towns of Jackson, Sutter Creek, Amador City, Drytown and Plymouth are on it. For many years alternating with Nevada County as the state's chief gold producer, Amador may drop back to third place in 1920.

The year 1920 has been a disastrous period for the county's quartz mines. Early in the year it was believed that the underground fire in

Photo No. 51. Argonaut Mine, near Jackson. Photo by C. A. Logan.

the Argonaut and Kennedy mines was under control, and milling was resumed at the Argonaut. Early in March, 1920, however, fire was found in the 3300 level of the Kennedy, apparently having eaten its way through caved ground in old workings which were thought to be securely closed, as all communicating drifts had been bulkheaded off. Doors of four-inch planks were at once put in on every level of the Kennedy to keep floating timbers out of the shaft. Filling with water through the Kennedy shaft began March 17 and stopped April 11. In June, water was standing at the 2700 level in the Kennedy shaft.

The Argonaut Company began unwatering in early summer. It was found that the task was too big for the one plant, and early in the fall an agreement was made whereby the Kennedy Company also began unwatering and good progress is being made (November, 1920). With no untoward accidents, it is hoped that both mines will be unwatered in the first quarter of 1921. There is room for fear, however, that conditions about the 3700 level in the Argonaut will be such as to seriously retard work below there, so no forecast can be made.

The Argonaut Company should be extremely anxious to resume mining and milling, as they were in richer ore when milling stopped early in March, than had been found in many years. With the good grade of ore continuing and allowing for a normal average mill capacity of 70,000 tons a year, this property should produce about $1,000,000 annually.

Costs at the Argonaut during 1918, which are the last obtainable for a full year on account of interruption to operations during 1919, are shown below. Incidentally it may be said that tonnage milled in 1918 was the largest ever crushed.

COSTS AT ARGONAUT MINE, 1918.

By courtesy of N. S. Kelsey.

Stoping	$3.316	
Development	0.823	
Hoisting	0.877	
Surface	0.448	
Total mining cost		$5.464
Bullion	$0.424	
Concentrate	0.301	
Slimes	0.166	
Total milling cost		$0.891
General office expense at mine		0.624
Total working cost		$6.979
Construction		0.404
Grand total cost per ton		$7.383

The above figures are for 73,890 tons milled, or an average of 6157 tons a month. In February, 1920, 7613 tons were milled but in spite of the increased tonnage, total working cost increased:

COSTS AT ARGONAUT MINE, FEBRUARY, 1920.

By courtesy of N. S. Kelsey.

Stoping	$2.885	
Development	1.294	
Hoisting	0.860	
Surface	0.385	
Total mining cost		$5.424
Bullion	0.532	
Concentrate	0.354	
Slimes	0.243	
Total milling cost		$1.129
General office expense at mine		0.592
Total working cost		$7.145
Construction		0.18
Grand total cost for 7613 tons		$7.325

Total labor cost per ton was $3.487.
Total cost of supplies per ton, $1.937.
Timber cost per ton mined, $0.60.
Labor of timbering per ton mined, $0.65.

Costs after reopening are expected to be increased 25¢ to 30¢ a ton above the February, 1920, figures.

The Argonaut shaft has reached an inclined depth of 4800 feet (vertical depth 4050 feet). They have the footwall vein only of the Mother Lode, with a hard schist footwall carrying a heavy gouge and a very heavy hanging wall of Mariposa slate. The ground has to be timbered heavily and stopes are kept filled within one floor of the back. The ore-shoot has a maximum length of 500 feet, and an average thickness of 14 feet. Levels are opened every 150 feet and raises put up 90 to 110 feet apart for stoping. The 4500 level and above are about worked out, and mining will be resumed on the 4650 and 4800 ft. levels.

The mill is equipped with 60 stamps of an average weight of 1000 lbs. each, dropping 96 times a minute.

Milling stopped at the **Kennedy Mine** on March 10, 1920. Whether or not regular operations will be resumed when the property is unwatered has not been stated, but the labor situation, cost of operation and grade of ore, considered together, do not encourage resumption of work.

The Kennedy workings have reached a vertical depth of 4050 feet. At the time of closing, work was going forward on the 3450, 3600, 3750, 3900 and 4050 levels with little ore left above them. With a heavy gouge on the footwall and a badly swelling slate hanging wall, it is necessary to use heavy square setting all through the mine. All stopes are filled with waste obtained by raising in the hanging wall or drifting.

This property has a mill of one hundred 1250-pound stamps with 42 Frue vanners. The mill is operated by electricity. Under normal full time operation on present grade of ore, it is capable of a production of $800,000 to $900,000 a year. The slimes plant has been torn down.

The company has a steam plant capable of generating 1800 h.p., but normal requirement is 1200 h.p., largely used for operating the 800-h.p. hoist which has a maximum speed of 2200 feet a minute. They burn crude oil and have their own oil pipe line to the mine from Martell, and ample oil tank capacity for storage at the mine.

Bunker Hill Mine. Milling at the Bunker Hill Mine ceased in February, 1920, because of high cost of operation brought about by abnormal industrial conditions. Since May, 1917, the mill had been operated at one-half capacity or less, in the vain hope that "normal" conditions would ensue. This property had been operated at a profit steadily for 11 years and had paid 123 dividends totalling $1,000,000 up to September, 1916, when dividends were suspended. Underground work is still going on. The shaft was sunk to 2800 feet and a winze has been sunk 640 feet below the 2800 level. The hanging wall vein is being explored on the 3200 and 3400 ft. levels. No work is being done above the 2800 ft. level except running the pumps, which are located on the 800, 2100 and 2400 ft. levels.

This company in August, 1914, reported a total operating cost of $3.34 a ton. The present cost, judged by result of their last operations and cost at similar properties nearby, would be very close to $7 a ton. To November 1, 1920, the crosscuts on the lower levels had not developed ore that could be profitably treated at such cost. Thirty men were employed; the full crew is 120.

The mill contains 40 stamps, 24 Frue vanners, 5 Deister Overstrom concentrators and a 5 ft. x 6 ft. Hendy ball mill. Mill practice consisted of stamping and amalgamation, followed by concentration on the Deister tables, after which the sands were ground in the Hendy mill and the entire pulp was concentrated on the Frue vanners. Mill capacity is 200 tons a day. Cost of treatment was reported to be 25½¢ a ton in 1914 and over twice as much in 1920. Electric power is used throughout.

The **Central Eureka Mine** at Sutter Creek is producing steadily. After being operated at a loss for many years, during which 48 assessments were levied and only low grade ore was found, the courage and

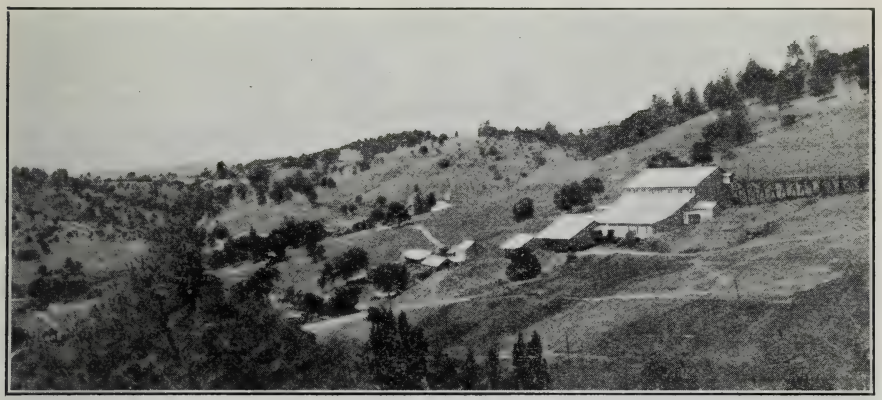


Photo No. 52. View of Mother Lode District in Amador County, showing (1) in right foreground, Bunker Hill Mill; (2) in center, the Treasure Mine; and (3) in left background, the headframe of the Fremont Mine.

perseverance of the stockholders of the Central Eureka were rewarded by the finding of very good ore in considerable quantity on the lower levels. The workings have now (November, 1920) reached a depth of 3900 ft. During the past year and a half the ore has been coming from the stopes of the 3500, 3600, and 3700 ft. levels, with a little from the 3350-ft. level.

Geological conditions have proved puzzling in the Central Eureka, and recent success has been due in large measure to the active exploratory work directed by Superintendent Howe. Exploration of the east and west country, which was recommended by C. E. Julihn in 1917 after the retiring directors had concluded the mine was exhausted, was first put in effect that year. An east crosscut was driven a distance of 774 feet on the 700-ft. level and on the 1800-ft. level, a west footwall crosscut was driven 717 feet without results. A hanging wall crosscut south of the shaft on the 2540 level found some ore, but for two years more the average grade of ore milled was too low to pay expenses. Good ore was finally struck on the 3500 level and stoped up to the 3425 level; a winze was sunk from the floor of the north 3500-ft. drift a depth of 105 ft. and a level driven at a depth of 85 ft. For 50 feet north of winze and 80 feet south of it, this level was in $20 ore or better. This shoot was 1 to 2 feet wide on the 3425 level; 7 feet wide on the 3500 level and 14 feet wide on the winze level,

but widened to 21 feet and improved in grade north of the winze. Other possible oreshoots were indicated but not explored on both footwall and hanging wall. During 1919 there was heavy expense on account of repairing pumps, shaft, drifts and crosscuts in the South Eureka which had to be used in keeping water out of the Central Eureka.

During the year ending April 22, 1920, a total of 34,705 tons of ore were milled from the 3500, 3600, and 3700 levels principally. This ore had an average assay value of $13.15 a ton and an extraction of $12.40 a ton or 94.31% was made. About one-quarter of the ore came from the so-called south shoot on the 3500 level, but this shoot is

Photo No. 53. Central Eureka Mine, Sutter Creek.

spotted, and apparently faulted between the 3500 and 3700 levels. The 3700 north stope on the north shoot averaged over $20 a ton. Of the total recovery, 85% was bullion.

Late work indicates that the vein in the lower levels enters the greenstone. The winze has been sunk to 3700, and the shaft to 3900 ft. Drifts have been run 70 feet north and 77 feet south in fine grade ore on the 3900 level and a stope begun. Both walls are being aggressively prospected. The 3600 level has been driven a total length of 415 feet south of the winze in search of the south ore shoot.

Milling has been interrupted during the summer by power restrictions. This property's mill contains thirty 1280-lb. stamps, dropping 96 times a minute and crushing through 24 mesh screen. Concentrates are saved on 16 Frue vanners. The mill capacity is about 3500 tons a month. Electric power is used except for the hoist, which is steam operated, using oil fuel. The Central Eureka and South Eureka are connected on the 1600 and 2540 levels. Water from the lower part of the Central Eureka is pumped to the 2540 level and piped to the South Eureka pump station, which is maintained and operated by the Central Eureka Company. Heavy timbering is required consisting of 14″ x 14″ square sets on the north end and stulls and posts on the south end.

The **Fremont Mine,** lying just north of the Treasure on the Mother Lode, is being unwatered after lying idle about two years. This property before closing, produced 200 tons a day of average Mother Lode ore carrying about $5 a ton. The reduction equipment comprises 40 stamps of 1000-lb each and 16 Frue vanners.

The **Keystone Mine** at Amador City was closed late in 1919 and the reason given at that time was the lack of room for storing tailing. The mine has been idle since. It is one of the properties that could be worked at a profit under pre-war conditions.

Old Eureka Mine is still being prospected. The bottom of the old workings was at 1965 feet. The present company has sunk the shaft to 3500 feet and has driven levels at 1700, 2125, 2950 and 3500 feet. Total drifts up to July 1, 1920 were 1720 ft. on 1700 level; 1345 feet on 2125 level and 1685 feet on 2950 level. Crosscuts totalling about 1500 feet had been driven into the foot and hanging walls. According to reliable report, no ore that would pay to mill under present conditions has been encountered, although low grade rock has been found.

The **Plymouth Consolidated Mine** at Plymouth has reached a depth of 3050 feet and good ore has been found on that level. Shaft sinking has been going on here the past summer and work has been done on the 2750, 2900 and 3050 levels. In the late summer milling was curtailed but has been resumed at the rate of about 300 tons a day. William J. Loring, in a recent article* states that the main vein was poor or unpayable from the 2450 level to the 3050 level, where the vein north of the shaft is said to be up to 12 feet in width and assays $20 a ton or more. Loring states the shaft is to be sunk another 600 feet during 1921.

The mill of the company was an innovation in Mother Lode practice when it was put in operation. It is described in this Bureau's last report on the Mines and Mineral Resources of Amador County.

The **Treasure Mine,** adjoining the Bunker Hill on the north, has reached a depth of 2470 feet, of which the last 870 feet is a winze. The following levels were being worked at time of last visit: 1800, 2000, 2160, 2320, 2470. The 1600-ft. level of the Treasure connects with the 1500 level of the Bunker Hill.

The ore being milled at the Treasure contains more sulphides than average Mother Lode ore. The treatment given differs entirely from that at any other mine on the Lode. It is to be regretted that the secretary of the company failed to reply to a request for a flow sheet of the mill. However, the writer visited the mill late in June, 1920, and the following notes include his observations as well as information furnished by the company.

Ore from skip dumps over 1-inch grizzley. Oversize to gyratory crusher, product to a trommel 10 ft. long, $1\frac{1}{2}$″ screen, minus $\frac{7}{16}$″ to fine ore bin, over $\frac{7}{16}$″, less than $1\frac{1}{2}$″ to coarse ore bin. Oversize from trommel to 7″ x 10″ Dodge crusher, and coarse ore bin. Belt conveyors feed coarse ore to a large Hardinge mill, and fine to smaller Hardinge mill. The large mill grinds to $\frac{1}{4}$″; pulp goes to a Bunker Hill revolv-

*Reopening of the Plymouth Mine and the Results, W. J. Loring, Mining and Scientific Press, Nov. 27, 1920.

ing screen (slots equal to 16-mesh) where it is thinned. Fine through screen goes to shaker plates and coarse on screen is sent to a small Hardinge mill, thence fines to shaker plates and stationary plates, and coarse by sand pump to launder and mixing with part of pulp from large mill goes to Bunker Hill screen. Coarse on screen to second small Hardinge mill; fines through screen to shaker plates. Fine product from last mill to plates; coarse returned to other small Hardinge mill. Small mills grind one-half to 100-mesh and all finer than 20-mesh.

Pulp off plates pumped upstairs to classifiers. Coarse (underflow) to 2 Wilfley tables; Wilfley tailing reground; fines (overflow) to cone classifiers, which discharge their underflow to 2 Overstrom concentrators and the overflow to 8 Frue vanners. The mill has recently been operating 16 hours a day and handling 90 tons, although rated at

Photo No. 54. Treasure Mine and Mill, between Drytown and Amador City. Fremont headframe in background.

150 tons daily on the 24-hour basis. Electric power is used. The large Hardinge mill has its own 35-h.p. motor, and the main drive for other machines is from a 75-h.p. 440-volt 93-ampere General Electric motor. When the large mill is stopped for repairs the smaller ones may be run on ore from the fine ore bin.

PLACER MINING.

Little placer mining is going on in this county. The Wicker hydraulic property near Lancha Plana does some piping each year. There are a few small drift mines near Oleta, Pine Grove and Volcano which give work to the owners and a few men. Hydraulic mining on a large scale has been promised at Volcano, where options have been taken on a number of small properties and work on ditches and a debris dam has been going on. This property is now called the Elephant Mine.

CLAY.

Clay properties in this county have been listed in this Bureau's recently published Preliminary Report No. 7, entitled "The Clay Industry of California," which may be obtained free from the main

and branch offices of the Bureau. The undeveloped clay resources of the Ione-Carbondale district (which is the center of the industry in this county) are immense, and have been only partially prospected. Besides the properties now being operated there are unexploited deposits on the 33,000 acres of the McKissick Cattle Company. Many of the active properties are also capable of being operated on a much larger scale, should demand arise.

The washing and tabling process used by the Philadelphia Quartz Company gives a clay which carries only a trace of iron oxide, sufficient to give a light buff product on burning. There appears to be room for further experiments on the clays here, for the purpose of obtaining a white burning product. Local men have also advocated the construction of a pottery in the district, to utilize the raw product where it is mined. With freight rates increasing, this project appears to have possibilities worth looking into.

COAL.

There has been practically no lignite mined in the county during the year. The following properties have produced in the past:

Buena Vista Coal Mine. Address J. J. Fitzsimmons, R. F. D. Ione, California. Mine is at Buena Vista, 6 miles by road south of Ione. There are three beds of brown lignite located at depths of 60, 68, and 70 feet, the principal bed being 11 feet thick. This bed has been developed by 2 vertical shafts 70 feet deep and by several hundred feet of drifts. It was last worked in 1913, and some of the coal was sold to local buyers, who did their own hauling. There is said to be no water at the level of the coal, but in sinking the last shaft a water-bearing sand was cut at a depth of 20 feet, and this necessitated pumping about 2500 gallons of water a day. Coal said to have cost 75 cents a ton at collar in 1913, and haul to the railroad at Ione would cost about $2 a ton. There is a good galvanized iron building at the mine and a hoist and small bunkers and head frame that might be used, but the old steam boiler appears to be in poor shape. Fitzsimmons claims an area of 40 acres is underlain by coal.

Harvey Mine. Address Fred Harvey, Galt, California. Mine is one mile north of Carbondale, the nearest railroad point to which a spur track could be run with practically no grading. The coal has been partially developed by a vertical 2-compartment shaft 88 feet deep and drifts driven north and south in the nearly horizontal coal bed which is said to have a maximum thickness of 20 feet. Drifts totaled 1000 feet. There is also an air shaft at the north end of workings. There is a large building in good repair, housing a 60-h.p. steam boiler and a 25-h.p. donkey hoist. The shaft is well timbered as far as seen and nearly full of water. There is a 40-ft. head frame and bins. The mine has been idle for several years.

Mine No. 4. Address lessee, Pioneer Wood and Coal Company, Sacramento, California. Bunkers at Lignite spur, one mile east of Carbondale; shaft is ¼ mile north of railroad and connected by tram. Formerly property of Ione Coal and Iron Company. A bed of brown lignite, 7 feet thick, and lying nearly flat, has been opened by a vertical

shaft 85 feet deep and several thousand feet of drifts on the bed, leaving pillars. Mining is by hand labor. The lignite is hoisted in cars on a cage. Screenings from the mine are used for fuel to generate steam for operating the mine hoist and hauling the empty cars back from the bunkers. The mine was last operated in January, 1920. The production capacity then was 500 tons a month and there was said to be two years reserve of lignite left in the bed. The number and extent of undeveloped beds of lignite under this region is no doubt considerable, as it has been found as far south as Lancha Plana.

BUTTE COUNTY.

In recent years, this county's gold production has been almost entirely from the dredgers on Feather River and its tributaries, in the Oroville district. Dredging operations there were summarized by the writer in our Bulletin No. 85, "Platinum and Allied Metals in California," published in 1919. As indicated in that report, the end of gold dredging on new ground in this county, will occur with the exhaustion of the holdings of the American Gold Dredging Company, located seven miles below Oroville. There are only two companies now operating dredgers in the county; the above named company has one boat with 6 cu. ft. buckets, and Natomas Company of California has a dredger with 15 cu. ft. buckets and one with 7½ cu. ft. buckets, but the latter boat has finished its ground and the larger one has for several years been working most of the time in old ground, formerly dredged by smaller boats. These left some pay on the bottom where the ground was deep, and in odd spots which were slighted in the effort to make a record for big yardage.

None of the hydraulic mines in the county have been active the past year, and only perfunctory work has been done on the quartz mines. Even the drift mines, which were for years the backbone of the mining industry here, have been either idle or worked on the most limited scale, due to the very short supply of water and the adverse conditions facing all mining enterprises.

Besides gold, this county in its mountainous portions contains many deposits of the industrial minerals, which lie for the most part unprospected because of their distance from railroads. Among these may be noted asbestos, barite, chromite, lignite, limestone, manganese, mineral water, mineral paint, soapstone and miscellaneous stone. Platinum in small quantity is produced by the gold dredgers and an occasional diamond is found in the placer mines.

Brief mention is made below of a number of placer mines which have shown some recent activity, but have not been mentioned in the Bureau's later reports. Other drift mines and quartz mines are noted in the Bureau's last report on the "Mines and Mineral Resources of Butte County."

PLACER MINES.

Alder Creek Mine. J. H. Rempel, Stirling City, owner. The property is in sections 5 and 8, T. 25 N., R. 4 E., 15 miles by road from Stirling City, and contains 60 acres, patented. The elevation is 5325 feet.

The deposit consists of cemented bench gravel 8 to 20 feet deep, on granite bedrock. It is situated near the head of Alder Creek, and is dependent on snow water for washing. Rempel has been working the property alone since 1897.

Beauty Placer Mine. S. H. Vandergrift, Stirling City, owner. The property consists of 160 acres along Alder Creek in section 6, T. 25 N., R. 4 E., 17 miles by road from Stirling City and at an elevation of 5200 feet.

The gravel is said to average 6 feet deep and 50 feet wide, and the pay is mostly on the bedrock. Vandergrift sluices the ravine every year with water from melting snow.

Blue Hog Mine. Feather River Land and Mining Company, owner; Paragalia Mining Company, lessee with option to purchase; Henry S. Porter, president, Long Beach; E. F. Woodworth, manager, Chico. The property contains 580 acres, patented, situated about 5 miles from Magalia and an equal distance from Paradise.

This old mine has been worked at intervals for nearly 40 years. It covers about three-fourths of a mile of a lava capped channel containing loose gravel on slate bed rock. The pay gravel is 2 to 5 feet deep and 70 to 100 feet wide. There is a main tunnel which was reported to be 1700 feet long early in 1920 and a drain tunnel 900 feet long; the former has been advanced during the last year. Over 1000 feet of main tunnel is said to have been driven by the present operators and they have mined a width of 100 feet for a distance of 400 feet upstream. The lower end of the ground is said to be rich, but a section of channel 2000 feet long is too low to be worked through the present tunnel.

Operations were nearly stopped by lack of water the past two seasons. The mine is supposed to have a normal supply of 800 inches of water, but this water right is in conflict with the Paradise Irrigation District. When sufficient water is available, mining is done by piping water to the breast and washing the gravel in sluices laid in the tunnel. The property is equipped with a compressor, 4200 feet of 10 inch to 2 inch pipe and 1700 feet of 14 inch x 16 inch sluice boxes.

Emma and Alder Springs Mines. Nimshew Gold Mining Company, owner; Chas. H. McDonald, lessee, Nimshew. The property consists of the Emma, Alder Springs and other patented claims totaling about 600 acres, in sections 14, 15 and 22, T. 23 N., R. 3 E.; five miles by road from Magalia and at an elevation of 2300 feet.

There is an old tunnel about 5900 feet long through which the narrow pay channel was worked up to the place where it was cut off by a later lava channel. A new tunnel 4 ft by 7 ft. in cross section is now 1500 feet long and is being driven ahead with the hope of picking up the channel again.

Some water is developed from the channel and more can be bought from Pacific Gas and Electric Company. At present only two men are working. Square set timbers costing $5 a set are used where required. There is plenty of timber on the property.

Hupp and Indian Springs Mines. Henry S. Porter, lessee; E. F. Woodworth, manager, Chico. The Indian Springs mine consists of 130 acres, patented, in sections 3 and 10, T. 23 N., R. 3 E., and the Hupp Mine contains 580 acres, of which 500 acres are patented, lying north of the Indian Springs on the same channel. The properties are five miles by road from Magalia.

When the last previous work was attempted on the Indian Springs mine, the owners of the Hupp obtained an injunction on account of alleged trespass. The present plan is to work through the old 6500 ft. tunnel on the Indian Springs property. Comparatively little has been done yet on account of the scarcity of water during the past two

years. Square sets and cap and post timbering are used. There is a blacksmith shop, blower, small Rix air compressor, 250 feet of sluice, 500 feet of water pipe and 6000 feet of air pipe on the property. Gravel is hauled out in trains by a mule. Electric power is available 300 feet distant, and a normal supply of 50 inches of water, but less in dry years, comes from the tunnel. The gravel formerly mined is said to have paid $2.50 a car for a height of six feet and the channel was breasted 80 to 100 feet wide.

Kirby Mine. Geo. W. Kirby, owner, De Sabla. The property covers 3500 feet along the course of a lava capped channel in the E. ½ of section 34, T. 24 N., R. 3 E., 7 miles by road north of Magalia. Later work consists of a shaft 4 ft. by 8 ft. in cross section, 175 feet deep, and a tunnel 5 ft. by 7 ft. in cross section and 300 feet long. The gravel is free wash, but hardly enough work has been done to show its width, depth and tenor.

Little Johnny Mine. Elmer Johns, owner, Stirling City. The property contains 120 acres, covering ½ mile along the supposed course of an ancient channel, in section 20, T. 25 N., R. 5 E., twenty miles by road north of Stirling City at an elevation of 6200 feet, in the highest portion of the county. The gravel channel is 150 to 200 feet wide, and the bank is 20 feet high, the lower 5½ feet being gravel. The property is worked by ground sluicing with snow water during the spring thaw. There is ½ mile of ditch and pipe line, taking water from Brown's Ravine.

Royal Drift Mine. Royal Drift Mining Company, Napa, California, owners; R. M. Butler, president; Forrest H. Snow, superintendent. Properties comprise about 1000 acres, unpatented, 24 miles by road northeast of Chico in Forks of Butte district, in T. 23 and 24 N., R. 3 E., at elevations of 2200 to 2600 ft. The Double Eagle, Weed and Straughn mines, former producers but now idle, have been bought by this company. There are a total of 6000 feet of drift workings and 2000 feet of inclines on the holdings and some hydraulicking has also been done in former years. The present company's work is still in the development stage. There is a hoisting and pumping plant on the property and water is obtained from springs and from an old tunnel.

Steifer Mine. P. B. Steifer Mining Company, Magalia, owners. Comprises 80 acres, patented, in section 12, T. 23 N., R. 3 E., 3 miles by road from Magalia and at an elevation of 3000 feet.

The company has done no work since the last report, but the property was recently leased to B. J. Klarman of San Francisco.

LIGNITE.

Lott Ranch. C. F. Lott, owner, Oroville. The property is 8¼ miles by road from Oroville in section 12, T. 20 N., R. 3 E., in Coal Cañon, at an elevation of 500 feet. There are reported to be two strata of brown lignite at depths of 20 feet and 30 feet below the surface, but the old workings were obliterated by a washout and landslide several years ago, and the beds in place underground are not now accessible, although there is considerable of the lignite buried in the old mine dumps.

Between 1860 and 1880 the lignite was mined through an adit and was hauled to Oroville, where it was heated in retorts to furnish gas for lighting. A few of the very old buildings in the town still contain the old gas pipes, but there is no one alive in the neighborhood who knows the extent of the underground workings on the coal bed. The best sample possible was taken for analysis, but returns showing the character of the lignite have not yet been received. There is little doubt, though, that it will prove to be similar to the lignite mined at Lincoln and near Carbondale. Other beds of this lignite have been found in several wells bored for water and in search of oil, in the Oroville district.

CALAVERAS COUNTY.

This county's principal mineral products are gold and copper. Small quantities of asbestos, clay, chromite, lead, marble, mineral water, ocher, platinum, silver, and stone of various kinds have been produced in recent years.

Gold and copper mining have both been in a depressed condition during 1920. Many of the largest gold mines in the county have always had low-grade ore, and there has been no incentive to reopen these under present conditions. There have been, nevertheless, a number of gold mines on which work was resumed during the year. Among these may be noted the following, which were not visited by the writer on account of the unusually early storms:

Late in the fall the old Bishop drift mining property at Vallecita was being reopened with encouraging results. The Blair mine, a mile and a quarter west of Angels Camp, is being reopened by the Triple Lode Gold Mines Company, and late in the fall a mill was being put on the property. The Golden Gate Exploration Company have been prospecting and developing the Sheep Ranch mine during the past three years and have installed much new surface equipment, including a 20-stamp mill and cyanide plant. This mill is said to have been put in operation during the present month (January, 1921). A 3-stamp mill was started on ore at the Port Arthur mine near Angels Camp about November 1. The Ranier Drift mine east of Altaville and about a mile from Angels Camp, was being unwatered in November. A 30-stamp mill has lately been moved to the Waterman mine near Angels Camp.

No county has felt more keenly than Calaveras the hardships forced on the gold mining industry by rising costs of operation and the stationary price of their product, and none would be more benefited by the passage of the McFadden bill. The gold production from quartz mines in this county in 1920 was almost entirely from the Carson Hill Mine.

Copper mining, too, has been in an especially bad way during 1920, and production for the year will be only a fraction of that for 1919, which in turn was less than one-third the yield for 1918. For many years Calaveras County was second only to Shasta County in copper production, but for three years past has been in third place, and far outdistanced by Shasta and Plumas counties. Many of the smaller copper mines on the Foothill Copper Belt were equipped during the war and gave promise of profitable careers, and the high price for copper also induced the larger companies to mine out their ore reserves as fast as possible.

The slump in price after the cessation of hostilities was accentuated by the increasing accumulation of refined copper, which could not be marketed because Germany in particular, and also other foreign countries, were unable to buy. The price of copper has now reached a point where few, if any, of the California mines can produce this metal at a profit, unless the ore carries sufficient gold and silver to help pay operation costs. The price of copper will improve with changes in the exchange rate in favor of those countries which have formerly been our principal copper customers.

The Campo Seco smelter of the Penn Mining Company was closed March 1, 1920, and has remained idle. The Calaveras Copper Company at Copperopolis also reduced their operations, and suffered a further set-back late in the summer from an underground fire. This company had already cut down their production over half in 1919. The smaller companies have made little production during 1920.

The following notes on quartz mines summarize the more important developments at the properties named, since the last report:

QUARTZ MINES.

Angels Mine. Estate of James V. Coleman, owner. Consists of seven patented claims, over 100 acres, in Angels Camp townsite.

This well-known mine was closed March 1, 1918, on account of the death of Coleman, the former owner. At time of closing, the deepest level was at 1050 feet, and ore was being mined on the 200, 400 and 500 levels. There is said to be considerable low-grade ore on the 1050 level, which is, however, quite a distance from the shaft. Costs of mining have been so high as to discourage reopening the mine. When running just previous to the war, this mine had a record for very low cost of operation, and was making a profit from low-grade ore. J. Fullen, superintendent, states that from September, 1914, to March 1, 1918, the mine produced $550,000.

The mine and mill equipment, described in last report, is still on the property. The mine hoist, etc., are in good condition, but the 40 stamps are light, compared with the up-to-date mills on the Mother Lode.

Angels Camp Deep Mining Company, 743 Call Building, San Francisco; John C. Benson, president. The property is partly in Altaville townsite, near Angels Camp, in section 33, T. 3 N., R. 13 E., and comprises the Demarest, McCauley, Pioneer, Martinusen, Johnson, Hale and Smyth claims.

There were some old shafts and crosscuts on the claims, including Pioneer shaft 187 ft. deep with 487 ft. of crosscuts on No. 2 level and Smyth shaft 140 ft. deep with 400 ft. of crosscuts on No. 1 level and 292 ft. of crosscuts on No. 2 level. The present company has sunk the Pioneer shaft to 500 ft. on an angle of 83° with stations at 300, 400 and 500 ft. and has crosscut 50 ft. on the 400 level and 135 ft. on 500 level. The veins strike 54° to 60° E. and dip nearly vertically between black slate and greenstone walls. The stringer lead formation varies from 5 ft. to 37 ft. in width on the second level. The northeast crosscut is bulkheaded off 75 ft. from the shaft, presumably on account of water. There are said to be other veins exposed in the crosscut beyond the bulkhead. The reported assays from this level indicate $5 to $6 ore. Late in October, 1920, no higher grade ore was reported from the lower levels.

Twenty stamps and 10 Frue vanners from the old Harvard mill at Jamestown have been moved to the Pioneer shaft and installed in a substantial mill building. There is an Angels Iron Works hoist operated by a 75-h.p. motor, a Giant air compressor operated by a 40-h.p. motor and an old Smith-Vaile double compressor with 100-h.p. motor.

No ore has been blocked out or milled and the mill is not supplied with power yet.

Black Wonder Mine. Calaveras Mining and Milling Company, F. P. Ferguson, president, 228 South Fifteenth street, San Jose, California. Comprises 2 patented claims and other patented land covering 3200 feet along strike of vein and totaling 160 acres, 9.2 miles by road southeast of West Point and 30 miles from Valley Spring railroad station. Property is on the East Belt.

Two well defined fissure veins averaging 18 inches to 2 ft. wide, striking N. 18° E. and dipping 70° W., have been developed. The walls of vein are hard siliceous Calaveras slate and mica schist. The ore is base; analysis of a carload shipped to Selby smelter by present operators showed 42% iron sulphides, 9% lead sulphide, and 1% to 2% zinc sulphide.

Former operators stoped the vein for 800 feet on the strike, above the upper tunnel. Present company sank a shaft 130 ft. deep on vein 5 ft. wide and of good grade. This is 1360 ft. north of point where a crosscut exposes apparently same vein 2 ft. wide. The carload of ore shipped came from the shaft and is said by superintendent to have contained 3 oz. gold and 17 oz. silver per ton. The shaft and upper tunnel were both giving considerable water. A lower crosscut tunnel was being driven which is to be 1300 ft. long when it strikes vein and will be 210 ft. below the collar of shaft.

Calaveras Mine. Under bond to Carson Hill Gold Mines Company, Incorporated, 614 Crocker Building, San Francisco. Property is near Melones and on the slope of Carson Hill, and the depths of levels are measured from the apex of vein on New Year claim, near top of Carson Hill.

The vein has been developed by an adit called 1000 level, entering hill near Melones and following vein nearly north for nearly 2000 feet with frequent crosscuts. A winze from 1000 level 950 ft. in, connects with 1123, 1250 and 1375 levels, on which several hundred feet of drifting has been done, mostly to the north of winze. The vein has a swelling footwall of amphibolite, and heavy amphibolite hanging wall, and averages 15 ft. wide, of which an average of 7 ft. is said to be ore. The ground has to be timbered closely and is hard to hold open long, so it is desirable to stope out as fast as possible and let it cave.

Some ore was stoped under contract in 1919 but work has since been suspended and mine is idle. Ore mined on lower levels was said to run $5 to $7 a ton. The ground above 1000 level is in bad shape and nothing has been done there by the present company; there was an old shaft 600 ft. deep and surface workings.

Finnigan Mine. Talbot Brothers, of Carson Hill, owners. Under bond to Lewis, Gilman and Moore, Hobart Building, San Francisco. Covers 2100 feet on the Mother Lode on north side of Carson Hill, adjoining Reserve and Enterprise claims of Melones Mining Company.

The vein previously mined is on the footwall of the bull quartz, and is same vein as worked by Melones Company, whose immense glory hole adjoins the Finnigan. This ore body, consisting of a stringer lead and impregnations of the amphibolite schist wall rock, has a maximum

width of 100 ft. in the glory hole and is low grade, but was worked before the war by both these companies at a small profit.

The present operators have been prospecting the property off and on since late in 1919, and for some months encouraging reports have been given out. There are 2 old tunnels known as Hawkins tunnel 465 ft. long and Talbot tunnel, 400 ft. east from glory hole; besides this old work, the operators have started a winze and done some new crosscutting to east vein.

Gold Cliff Mine. Utica Mining Company, owners. It lies just west of Angels Camp on a west spur of the Mother Lode. There are 8 claims in the group, which has been owned by the Utica Company since 1884, but has been known and worked since 1850.

The Gold Cliff ore body is a thick chimney of solid white quartz and crushed mineralized wall rock, lying at the juncture of two veins. The footwall is amphibolite schist, broken, highly mineralized and not well defined; the hanging wall is smooth, hard amphibolite schist, deeply grooved by movement. The shoot dips 30° to 65° N., averaging 45° to the 1600′ level. Between 1600 and 1700 levels there was a horizontal fault throwing ore several hundred feet north; at 1700 level they started a winze which was sunk 270 ft. when mine was visited late in 1919, but has been sunk deeper. Stoping was going on from 1700 and 1900 levels. The vein had a width of 25 feet on the 1700 level. It is stoped in large chambers, with little timber. The gold is said to be 65% in the sulphides of the schist, and the solid quartz is usually low grade. Sulphides form as high as 10% of ore.

The mine and mill were closed down in April, 1920, and have been idle since. Superintendent states the company stopped operations because of high costs, and inefficiency of labor. They feel that the ore can best stay in the ground till conditions improve. They see no advantage in producing gold at the fixed price of $20.67 an ounce during a period when the prices of mining supplies are two to three times normal, and mining labor only fifty per cent efficient, or less, even though operations were yielding some profit.

This mine is in condition to resume operation promptly. It, as well as many others on the Mother Lode, would no doubt be worked if the McFadden bill were passed.

Lightner Mine. Lightner Mining Company, Alex Chalmers, manager. One fractional claim, lying between the Angels and Utica mines at Angels Camp. Unwatering the mine was begun in February, 1920, but work ceased September 1, 1920, on account of restrictions laid down by the state power administrator, which are alleged to have made it impossible to get enough power to operate the pumps. The shaft is about 1000 ft. deep, and had been almost cleared of water when work ceased.

Melones Mine. Melones Mining Company, owner. This company has done no work during the year, but some of the underground workings which connect with the Morgan mine, and the electric traction equipment, have been leased to the Carson Hill Gold Mines, Incorporated, for use in developing the Morgan mine and in delivering the ore from the mine to the mill near Melones on the river.

Morgan Mine. Carson Hill Gold Mines, Incorporated, owner; W. J. Loring, general manager, 614 Crocker Building, San Francisco; A. D. Stevenot, superintendent at mine. The property covers a portion of Carson Hill, adjoining the camp of same name and the Melones mine. The mine was discovered in 1850, and is said to have yielded $2,800,000 between February, 1850, and December, 1851, to the discoverer, Hance, and his six partners, for one of whom the mine was named.

The operation of the property during 1919 was briefly noted in our Preliminary Report No. 6. Since then the mine has been operated steadily. The mill has been crushing about 9000 tons of ore monthly in recent months, and 10 stamps have just been added to it, which will give it a capacity close to 15,000 tons a month, as the average stamp duty is over 15 tons a day, due to coarse crushing followed by use of Hardinge mills.

Early in 1920 the company leased part of the Melones mine and their electric traction equipment. Melones shaft, which is near the south end-line of the Morgan mine, is being used to develop the lower portion of the Morgan ground, and some of the tunnels are used in hauling the Morgan ore to the mill near Melones.

Besides the 100, 200, 300, 360, 425, 550, 675, and 865 levels, which were open in 1919, the work has been done on the following levels: 985, 1100, 1200, 1350, 1450, 1600, 2800, 3275, and 3375. The use of Melones shaft has, of course, made it possible to open the ground so rapidly, and has greatly reduced development expense. The 985, 1100, 1200, and 1350 levels had each been drifted north for distances of 200 to 350 feet in October, 1920, and short drifts had been run on the other levels.

In sinking on the hanging wall vein they have encountered what they call "flat veins" on the 1100, 1350, and 2800 levels. These are the fillings of fault fissures which dip the same way as the main vein, but at a flatter angle, and throw main vein up. There is payable ore in these flat veins, but it is much lower grade than the hanging wall vein. The flat veins strike N. 70° W., and dip 30° E. Work has been done on the upper flat vein on 1200, 1300, and 1600 levels. A stope on it on 1600 level is 60 ft. long and 10 ft. wide.

On the hanging wall vein, the stope on 550 level is 225 ft. long; on 675 level, 320 ft. long and with a maximum width of 41 ft., on 865 level, over 300 ft. long and on 1100 level nearly 200 ft. long. Besides the work on flat vein and hanging wall vein a stope 200 ft. long has been opened on the 550 level on the footwall vein. During six months up to November 1, 1920, over 6000 feet of development work and 1000 feet of diamond drilling has been done on the properties controlled by this company, including work done on the Calaveras and Adelaide.

In last year's report (Preliminary Report No. 6) the writer estimated that if the Melones workings could be used to handle and transport ore from the Morgan mine, "the cost of operation could be reduced probably to about $4.75 a ton." The company states that the average total operating cost for nine months in 1920 was $4.84 a ton, due to reduction of transportation cost, the elimination of shaft work incidental to use of Melones workings, and the handling of increased tonnage. The ore is hauled now 4000 feet by electric locomotive. The average tenor of mill-heads has been reduced, partly because of lower grade of some of the ore, but the total yield for the year will be about the

same as in 1919, giving a production of about $2,100,000 for the two years since the mine has been reopened.

GREENSTONE.

Greenstone has been quarried at the old Ghost Mine during 1920 by Charles Lillie. This old mine is located near Angels Camp. The rock was crushed and shipped to Richmond where it is used for surfacing prepared roofing.

MARBLE.

The **Eagle Marble and Lime Company** was organized during last summer to work a marble property in section 29, T. 3 N., R. 14 E., a mile and a half east of Vallecita. This property, formerly known as the Eagle marble quarry, has made a small production of marble in the past, but has been idle for several years. The new company planned to put in some marble cutting machinery and to begin operation soon.

The Calaveras marble belt, including the above and other small properties, is a continuation of the deposit quarried at Columbia in Tuolumne County.

EL DORADO COUNTY.

The gold mines of El Dorado County, famous since Marshall made his discovery in 1848 at Coloma, only 8 miles from Placerville, the county seat, have shown during the past few years the full effect of the adverse conditions everywhere confronting the industry. The Mother Lode traverses the county from near Nashville on the southern boundary to the Middle Fork of American River, a distance of about thirty miles, and on into Placer County. The many mines opened along this gold belt years ago have all been idle, except for limited prospecting work, in 1920.

In the northern part of the county where the Jurassic slate belt carrying the Mother Lode veins is split by an immense intrusion of what is now mostly amphibolite schist, there are found the "seam diggings", where the amphibolite and slate are filled with numerous narrow veins and stringers of quartz and calcite, in places carrying considerable free gold. The veinlets themselves are not continuous, but the belt as a whole is rather extensive on the strike, and has been worked successfully in years past by hydraulicking the decomposed upper portions. Considerable interest has been roused this year by work being done on this belt at Spanish Dry Diggings.

The drift and hydraulic mines which were early operated on an extensive scale are far from worked out, although it is true that the more accessible and easily worked ground has been mined. Here, as elsewhere, successful drift mining calls for the investment of adequate capital, and the day is past when a pick, shovel and sluice were machinery enough. Unprospected or only slightly developed deep gravel deposits, that would require shafts or long tunnels are found near Newtown and Pacific, and many miners maintain with apparent reason that there is a channel extending many miles westward under the ridge from Pacific that has never been opened; there are also deposits at Indian Diggings, Fairplay, Omo, and northeast of Georgetown. There is only a little activity in drift mining to record for the past year.

There has been some prospecting of copper properties on the foothill copper belt, but no production of copper noted in 1920. Most of the chromite properties have been idle with one property producing concentrate up to the last quarter of the year.

The county has immense resources in limestone and there has been steady production during 1920. The excellent deposits of black roofing slate near Placerville and Kelsey have remained unworked this year although it was stated in Placerville late in October that one quarry was to be equipped and opened. Soapstone for various uses has been shipped from three properties near Shingle Springs and Latrobe.

The following notes on individual properties are intended to indicate briefly the progress of mining in the county during 1920.

GOLD QUARTZ MINES.

Armstrong Mine. Armstrong Mining Company, Ninth and Broadway, Oakland, California. Prospecting two claims 2½ miles from Grizzly Flat and adjoining the line of the Diamond and Caldor Railroad. A

vertical shaft 100 ft. deep and an inclined shaft 114 ft. deep reported sunk and 180 ft. drifted in the summer of 1920, on a narrow quartz vein in granodiorite. Work was planned further to prospect the supposed intersection of the north striking vein with an east striking vein. Equipment, 40-h.p. steam boiler, 3 ft. Pelton wheel, 30 h.p. Joshua Hendy hoist, Rix air compressor, 2 drill capacity. P. A. Paulsen, Grizzly Flat, manager.

Grit Mine. W. A. Bucknam, Spanish Dry Diggings via Greenwood, owner. Grit Gold Mining Company, 410 Bryte Building, Sacramento, lessee with option to purchase. Comprises five claims, two of them patented, and covering a large part of the old Spanish Dry Diggings, 17 miles from Auburn in section 30, T. 13 N., R. 10 E.

The property has been owned by the Bucknam family for about 40 years and was previously worked by Spaniards, who took the dirt down the steep cañon side to the American River for washing. In the Grit claim in 1865 a mass of beautifully crystallized gold was found which weighed 101.4 ounces troy. This was found in a shaft a few feet below the bottom of the old hydraulic pit. The upper decomposed portion of the auriferous zone in this mine and in similar properties in the vicinity of Georgetown was worked successfully by hydraulicking, ground sluicing and shallow underground workings down to average depths of 125 feet to 150 feet, where hard rock was encountered. Such ground, handled as a whole, paid handsomely, going at times $2 to $3 a yard.

The gold here occurs free in narrow quartz and calcite veins or seams, in amphibolite schist and slate. The occurrence of zones rich in iron in the amphibolite schist may have influenced the deposition of the gold. The present working entry, an adit driven from the river slope possibly 150 feet below the original outcrop, was driven years ago and was connected with the surface by a shaft which was presumably sunk on ore. The adit was on the vein for about 75 feet. King and Compton, working under a lease from the owner previous to the formation of the present company, began sinking in the floor of this drift, and at the time of the writer's visit (November 10) had put down two winzes, each 18 feet deep and 30 feet apart. In one of these winzes "specimen" ore was found and some of it could be seen in the bottom. From this winze a drift on the formation had gone about 18 feet. The vein appeared to be increasing in width with depth, and consisted of quartz and calcite with a good gouge on one wall. The amphibolite and slate walls carry considerable coarsely crystallized pyrite, said to be auriferous, but no assays of this were available. Not enough work had been done to indicate the probable extension of the vein on the strike, but it seems probable that the specimen ore will be found in a relatively narrow chimney.

The mine needs to be equipped with a little machinery to permit sinking an additional 100 or 150 feet directly in the ore. The "formation" between walls in the bottom of the winze where pay occurs is about 3 feet wide. The showing seems well worth following, and the ground deserves intelligent prospecting for other pay crossings. All the underground work to date has been with hand tools, and the rock in depth is too hard to permit much progress by such means. Six men were employed when visited and stock was being sold. The total reputed output of the property under past operators was about $300,000.

Hines-Gilbert Mine. Hines-Gilbert Gold Mines Company, 510 Bryte Building, Sacramento, California. This prospect is in the west ½ of section 24, T. 13 N., R. 9 E., 20 miles from Auburn via Spanish Dry Diggings, the last mile being steep trail. The five claims lie partly in Placer County and partly in El Dorado County, in the steep cañon of Middle Fork of American River. It is estimated that 3 miles of new road, up the south bank of the river, would cut the distance from the railroad in half. The veins occur between slate and amphibolite schist walls, where the Jurassic slate belt which contains the Mother Lode veins is split up by intrusives. The prospecting work has been on the El Dorado County side.

Two veins, called Hanging- and Footwall veins, have been prospected, of which the former is thought to be the more promising. This vein has been traced about 400 feet on the surface. It strikes N. 20° W. and dips 80° NE. The development on it consists of short tunnels and open cuts, one tunnel running 81 feet parallel to vein, with a raise in the vein to the surface. All the work is superficial and well up on the hillside. The vein averages 5 ft. to 6 ft. wide, and the unoxidized ore is reported to run $6 to $9 a ton. A crosscut 240 feet long was run to the Footwall vein near the river. This is now caved about 100 ft. in. A raise toward the surface from this tunnel lost the vein about 20 feet up; raise is also caved. Some other shallow work has been done this year near the mill, in the slide material, which yielded some broken quartz at times carrying free gold, but no vein in place was found.

The mill was run a few weeks during the past summer and some ore yielded about $4 a ton in free gold, it is reported. The sulphides were not saved.

Water is taken from Cañon Creek through 6 miles of flume and ditch of perhaps 35 miners inches capacity. There is about 600 feet fall at the mill and a 3-ft. Pelton wheel furnishes power. Mine equipment includes an Ingersoll Rand 3-drill compressor, 750 ft of 11-inch pipe, 750 ft. of tramway, and dwelling and compressor houses. Mill contains 10 medium weight stamps, Hendy 10-inch Blake type rock breaker, and 2 old Wilfley concentrators, all operated by 3-ft. Pelton wheel. Reports have been made on the mine for the company by Lewis Hinds and the late J. F. Parks. Property idle in November, 1920. Capital stock 1,000,000 shares par value 10 cents each.

Josephine Mine, near Volcanoville, 8 miles north of Georgetown, has been prospected during the year by the Nevada-Pacific Exploration Company. A new level 400 feet below the old workings and 720 feet below outcrop was started and driven over 300 feet late in the summer when encouraging indications were reported.

This mine was profitably worked until the winter of 1889-1890 when a landslide wrecked the 20-stamp mill. The vein shows ribbon structure and lies between serpentine and slate walls. In places it shows mariposite, generally an indication of good ore. J. A. Shields, Auburn, owner.

Red Rover Mine, 3 miles southeast of El Dorado, has been prospected by E. C. Montgomery of Auburn and associates during the past year. After clearing some of the old works, a little drifting was done

that promised to open ore, but work was discontinued before positive results were obtained and the property is idle (December, 1920).

Wiedebush Mine, in section 20, T. 13 N., R. 11 E., northeast of Georgetown, has been worked during the year by Edward Spencer and Adolph Krauger of Vallejo under lease and bond. There is reported to be an ore shoot 70 feet long developed by a tunnel, with good ore still in the face, and said to be 3 to 4 feet wide. The ore is being milled under difficulties in a small roller mill, as water has to be pumped up about four hundred feet for mill use. Seven men are employed.

DRIFT MINES.

Hook and Ladder Mine. Owners, Selah, Joseph and Ellen Chamberlain, 850 Mills Building, San Francisco; lessees with option to purchase, Daniel M. Burns, 715 Call Building, San Francisco, and Bert L. Bryan, Smiths Flat, California. Property is in S. ½ of NE ¼ section 10, T. 10 N., R. 11 E., ½ mile from Smiths Flat on the Lake Tahoe highway.

This mine is on the ancient channel system worked profitably years ago under Smiths Flat. It had been abandoned for a long time previous to 1918, when reopened by Bryan. His preliminary work led him to believe there was still pay gravel that had been untouched. The former operators are said to have quit work when they came to a point where the stream narrowed and gravel was cut off by a reef of hard bedrock. Driving downstream past this, Bryan came again into pay gravel, about 80 feet above the old deep channel.

To work the gravel downstream (southward) from the present shaft, it was necessary to take up 32 feet of bedrock to get a grade of 4 inches in 100 feet for the bedrock working tunnel. The channel is estimated to have an average grade of 1 foot in 100 feet. With the 32-ft. depth to start, they believe they will have ample grade to run their tunnel 1500 feet, the whole length of the ground, and mine the gravel by raises.

The shaft is 145 feet deep, in rhyolite ash and granite. Two tunnels have been driven, the old upper tunnel 380 ft. long and the new lower one 330 ft. long. Where first cross-cut, the gravel is reported 50 ft. wide, 1 ft. to 2½ ft. thick and partly cemented, and consists of rotten granite and medium sized quartz wash lying on decomposed granite bedrock.

The first raise from the bedrock tunnel into the gravel was started the last week in September, and probably the first run will have been made before Christmas, 1920.

The mine is equipped with a 20-h.p. steam boiler, wood fired; 15-h.p. hoist, small hoist room and blacksmith shop, mine pump and about 100 feet of sluice. The mine yields enough water for the boiler, and a water ditch crossing the claim 10 ft. from the hoist can supply water for washing gravel.

Pacific Channel Mine. Owner, J. H. Zimmermann, Pacific; lessees, J. E. Sexton et al.; office, Palisade, Nevada; superintendent, W. E. Christian. This is the old Zimmermann Mine, beside the Lake Tahoe highway ¼ mile below Pacific House, and 18 miles from Placerville. The property has mineral rights along 2 miles of the supposed course of an ancient channel.

The channel courses southwest, is capped by 130 feet of andesite and lies on granite bedrock. Zimmermann worked the upper gravel through tunnels, but is said to have never bottomed the channel. At time of the writer's visit, late in September, 1920, the present operators had driven 1000 ft. of new tunnel and were expecting to break into the deep channel at any time. Three raises had been put up, encountering low grade rim gravel. The upper portion of the deposit as worked by Zimmermann was said to be 700 ft. wide; works now inaccessible.

Equipment and plant includes a 4 ft. x 4 ft. barrel gravel mill with automatic feeder, operated by Pelton water wheel, 50-ton gravel bin, and small mill building; small blacksmith shop, 10-h.p. Fairbanks-Morse gas engine, 7½″ x 6″ Chicago Pneumatic Tool Company air compressor, and 600 feet of 6-inch pipe. Mine workings yielded about 4 inches of water and more could be bought and brought in through 2 miles of ditch.

Rising Hope Mine. S. M. Warren and Company, Exchange Place, New York City. Mine is 3 miles by road southeast of Placerville, on Texas Hill in section 15, T. 10 N., R. 11 E. The property was operated for ten years by the present company and was closed during the past summer following the death of the manager, Geo. W. Englehardt. The property comprises 220 acres, 200 acres of which are patented, and covers 3500 feet along the course of an ancient channel which is buried under 240 feet of andesite and lies on slate bedrock.

The great amount of development work done by this company did not reveal any important amount of good pay gravel. Workings included Main North Tunnel No. 1, over 3500 ft. long, East Main Tunnel No. 1, about 3000 ft. long, and shorter tunnels, numbered 2, 3, 4, etc. Raises were put up from the drifts in several places to breast out fragments of terrace gravels, but these generally did not pay.

The property was supposed to be on the junction of the Smiths Flat and Newtown channels, but work done did not prove this, although the Newtown channel appeared to have been bottomed when the property was last visited. The gravel was cemented, medium sized and gray colored.

Property was equipped with a 50-ton barrel mill, compressor and building, blacksmith shop and office, and water and electric power were available. The barrel mill did poor work and would have been replaced if development had warranted.

Roundout Mine, also called the **Danaher,** which was in operation in 1919, was closed without any recorded production and remains idle. This property is 2½ miles northwest of Smiths Flat. The mine formerly produced considerable pay from a shaft 148 feet deep and 1000 feet northeast of the new shaft.

The recent work was through an inclined shaft 400 feet deep (100 ft. vertical) from which a drift had been driven 600 feet nearly east when mine was last visited. There was still estimated to be 300 feet to drive to strike gravel, and the operators thought they would have 500 feet of ground upstream to the old shaft. Workings were in granodiorite capped by andesite.

Equipment included hoist operated by 40-h.p. electric motor, pump operated by 25-h.p. motor and blower with 5-h.p. motor, blacksmith shop and cars. Richards and Fairchild, owners.

Wabash Deep Channel Mine. E. W. Claresse, Georgetown, owner. Contains 160 acres in section 26, T. 13 N., R. 10 E., northeast of Georgetown and 21 miles from the railroad at Auburn. This property was worked in 1856 and operation was discontinued when the channel was lost in 1867. It was relocated in 1907 and the owner is driving a bedrock tunnel in search of the channel. The tunnel has reached a length of 350 feet. There are also 4 old shafts on the property.

COPPER.

Big Buzzard Mine, also known as the **Derrington Ranch Mine,** about 10 miles northeast of Folsom, is being developed by the W. P. Black Company. Work has not yet passed below the leached and oxidized zone, but recent assays are reported to be very encouraging, indicating gold, silver and copper in paying quantities, with some lead and zinc.

Voss Mine, also called the **Camel Back Mine.** Owner, J. D. Voss, Elk Grove or Pilot Hill, California. Was under option during the past summer to Gold and Copper Holdings Company but has reverted to the owner without any new work being done. The property consists of 680 acres of patented land, mostly in section 11, T. 11 N., R. 8 E., about 11 miles by road from Auburn on Burner Hill.

A massive quartz vein striking N. 32° E. and dipping 65° to 80° west, can be traced at intervals for 3500 feet on the slope leading to the river. The vein has a maximum width of 28 feet at the surface but has not been exposed its full width in the tunnel. The vein has been prospected by two tunnels 65 feet apart vertically, the lower tunnel being about 300 feet below the highest point of outcrop. There is also a shaft 25 feet deep on this vein. No. 2 (upper) tunnel is a drift on the vein 123 feet and No. 3 tunnel is a crosscut for 165 feet then 67 feet on the vein, so that none of the workings have gotten entirely beyond the zone of surface oxidation and leaching. The quartz at the face of workings is of a peculiarly sugary texture and shows considerable chalcopyrite and pyrite, with some bornite, and shows indications of downward leaching. The vein here is so promising as to warrant further drifting southward toward the higher part of the hill, where depth sufficient to get below the leached zone might be attained on these levels.

The owner has the record of a great many assays which he states came from this vein and which indicate an average sufficiently rich in copper, gold and silver to make a good milling ore. To date, however, not enough has been done to give any hint of the possible amount of ore available. The sulphides have been completely leached out of the outcrop. So-called dikes crossing the vein appear to be pyritized zones in the amphibolite and may have influenced mineralization of the vein.

On the east slope of the hill about $\frac{1}{2}$ mile due east of the above there is a parallel vein of quartz as much as 18 ft. wide in places, which has been opened by a 200 ft. shaft, now caved, and a shaft 40 ft. deep connected with a crosscut to vein. Farther south are several short tunnels

in bad shape showing possible ore on the dumps, the best of which was outside a caved tunnel about which nothing could be learned. There is no machinery or equipment on the property, and only one small dwelling.

CHROMITE.

Placer Chrome Company Plant, is located near Rattlesnake bridge, 7 miles from Newcastle. This company's old mill, described in our Bulletin No. 76, was finally dismantled and abandoned in February

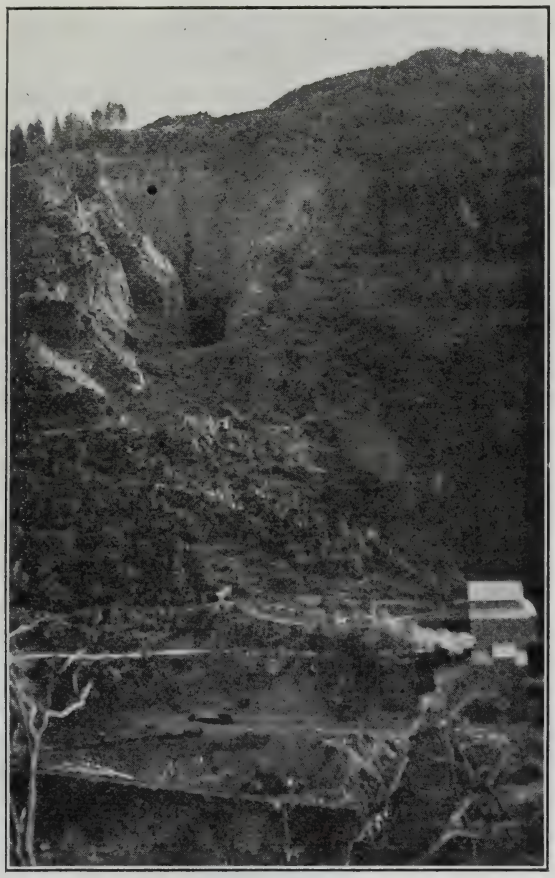


Photo No. 55. Quarry and loading plant at Mountain Quarry property of Pacific Portland Cement Co., on Middle Fork of American River in El Dorado County.

1920. A new mill building was put up at the foot of the 1700 ft. gravity tramway, and part of the machinery from the old mill was put in it. Milling began in January or February and continued till November, as orders came in; plant closed in November.

The reduction equipment consists of gyratory crusher, Hendy 50-ton ball mill, 4 Overstrom concentrators and a small ball mill to regrind middlings. Electric power was used. The ore as mined averaged about 15% Cr_2O_3 and the plant turned out about 5 tons of concentrate a day

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when working, but was only operated when orders were received. Ten men were employed when running full handed. Concentrate ran 50% Cr_2O_3, or better, and was used a good deal for chemicals and tanning. Product was hauled to Newcastle at a cost of $1.75 a ton, for shipment.

LIMESTONE AND ITS PRODUCTS.

El Dorado Lime and Minerals Company continue operation at their quarry and plant on the Placerville branch of the Southern Pacific Railroad a few miles west of Shingle Springs. This property is about 130 miles from San Francisco. It furnishes a very high grade white limestone at a low price for many industrial uses.

Farmer Lime Company. Blake and Farmer, Newcastle, California. Quarry, crushing plant and kilns are near Alabaster Cave, 7 miles east of Newcastle. This company is working a large upright lens of pure gray limestone, by open quarrying. The product is hauled in auto trucks either to Newcastle for railroad shipment or to local users.

The plant for grinding raw limestone comprises a Dodge crusher, Beers roller mill, belt conveyor, and bins for coarse rock and ground product. Capacity is about 20 tons daily, to pass $\frac{1}{8}$-inch screen. Electric power is used. For burning lime there are 3 upright oil fired kilns with a capacity of 150 tons a month each. Ground raw limestone is sold chiefly as a soil corrective and fertilizer. Burnt lime is sold locally to cyanide plants, and to farmers for tree spraying and fertilizer; it also finds a market through the foothill country.

Pacific Portland Cement Company continues the operation of its immense Mountain Quarries, on the south bank of the Middle Fork of American River 2 miles due north of Cool. The limestone is shipped to the company's cement plant at Cement in Solano County. The quarry is connected by the company's own broad gauge railroad with the main line of the Southern Pacific Railroad about a mile below Auburn. This road crosses the river on a concrete bridge and was an expensive work, which was justified by the immense amount of limestone available and the needs of the company. The limestone is blasted down from the open quarry face, now several hundred feet high, and falls through a shaft to bins and thence to cars hauled by trolley locomotive to the storage and loading bins, which deliver to the railroad cars.

There are large undeveloped limestone deposits in the county, particularly in this same belt extending from the river south past Cool.

SOAPSTONE.

Brandon Soapstone Deposit. Leased on royalty to C. S. Swift of Latrobe and W. S. McLean of San Francisco. It is about $\frac{1}{4}$ mile from Brandon spur on the Placerville branch of the Southern Pacific Company. A fair grade of grey soapstone had been found by a short crosscut and drift, but the lens seemed to be pinching down, being only about 2 feet wide when property was visited in May. A carload had been shipped to San Francisco.

Shingle Springs Soapstone Deposit. Leased on royalty to A. W. Prouty, Silas Granger and Cyril Heusner, all of Shingle Springs. Pit is about a mile east of Shingle Springs station. Four men including 2

of the lessees and a teamster, were employed when the property was visited in the summer. Soapstone was being shipped under contract to roofing manufacturers. A lens of greenish fissile soapstone had been traced for several hundred yards and had been worked in places by shallow pits. It was wheeled in barrows to a dump, loaded on wagons and hauled to the railroad for shipment. Buyers require a rock free from iron oxide stain so a good deal of hand sorting is done.

Swift Soapstone Mine. C. S. Swift, owner, Latrobe. The mine is about 300 yards from Swift spur on the Placerville branch of the Southern Pacific Company. The soapstone has been opened to considerable depth by a crosscut tunnel 350 feet long, with a drift 250 feet long in soapstone, with stopes and raises for mining. Some of the workings are going to prove hard to hold open. The rock is mined by hand labor using augers and drills, and is hand trammed to the bins beside the railroad where it is loaded into the cars. This is the largest operating soapstone property in the northern part of the state and is the best located.

The rock is hard and somewhat gritty, but has a uniform light gray color, which is an important property. The output is contracted to a large San Francisco firm for years. On the surface the rock is stained considerably by iron oxide but this defect does not appear in the mine, as in depth the iron minerals appear as black unoxidized specks.

NEVADA COUNTY.

This county was long the leader in gold production but of late years has been alternating with Amador County for second place, both of them falling behind Yuba County because of the adverse conditions which have been felt more severely in lode mining than in dredging. However, Nevada County far exceeds all others in point of total gold production.

With most of the hydraulic mines in the county closed, most of the gold comes now from the deep quartz mines at Grass Valley. There is some prospecting of drift mines, but although several of these promise early returns, none of them are producing on an important scale at present. Copper properties have not been worked in late years, although there are several former producers on the Foothill Copper Belt in the western part of the county. Asbestos, barite and chromite have been produced on a commercial scale lately. A granite quarry has been opened near Nevada City.

The mines of the county have been described at such length in this Bureau's report, entitled "Mines and Mineral Resources of Nevada County," which was published in 1919, that it is only intended here to summarize some of the happenings in the indusry during the past year.

ASBESTOS.

Sierra Asbestos Company, office, 710 Union Savings Bank Building, Oakland; mine address, Washington, California. The property is 2½ miles northwest of Washington by road and 21 miles by road from the railroad at Nevada City.

The property, and the methods of operating the mine and milling the ore, were described by the writer at some length in the report cited above. During the past year the company has been devoting its time to the development of the mine and the enlargement of the milling plant. They have developed a new quarry, and have installed a new aerial tram, besides the one formerly operated. Larger screens and fans have been put in the mill, and a set of 42-inch crushing rolls have been installed. These additions give the mill a daily capacity of 250 tons of crude ore.

BARITE.

Off-color barite occurs near Wolf, on Spanish Ridge 6 miles north of Washington, and a mile by trail from the Liberty Hill Hydraulic Mine. The first two deposits mentioned are too far from the railroad to be available at present.

Democrat Mine. William Maguire, Nevada City, owner. This mine is in section 24, T. 16 N., R. 10 E., about 6½ miles from the railroad at Alta and a mile by trail northeast of Liberty Hill mine.

This is a large deposit of off-color barite of good grade. It outcrops on the point of a hill at an elevation of 3450 feet, overlooking the steep canyon of Bear River.

During the past two years the property has been worked during the dry seasons and important production has been going on. During 1920,

Metals and Chemicals Extraction Company operated the property and shipped the ore to their plant at Melrose. It was treated there and the refined white barite was sold for use in lithophone and paints. The percentage of barium sulphate in the crude ore was high enough to permit shipment just as it was broken down in open cut workings. There is no overburden on the deposit. The only impurity, besides a minute amount of coloring matter, is silica, which occurs mixed with the barite in parts of the deposit. The ore was hauled to Alta in trucks for shipment. The hauling season is six to seven months.

GOLD QUARTZ MINES.

The year 1920 has been a very discouraging one for the mines of the county, and particularly for the quartz mines. There have been shutdowns, directly attributable to the unfavorable labor situation and to continuing high costs of power and materials. In the late summer and fall there was a power shortage which occasioned a so-called apportionment of power. This forced a curtailment of mining and milling operations. A great deal of dissatisfaction was evident in the county regarding the orders of the power administrator. They felt that their industry was not receiving the consideration to which it was entitled by virtue of its importance and the conditions under which it is being carried on. During the past summer an attempt was also made by the power company to deprive the mines at Grass Valley of the water supply which they had been using for power purposes since the early days. The rights of the mining companies and riparian land owners were so firmly established by use and so well grounded in justice that this effort failed. In cases of this kind it is unfortunate that the mining industry, in spite of its prime importance, is represented by such meager voting strength. The mining industry needs a state organization which will have to be as watchful of its members' interests as are the labor unions, for example, in legislative matters. The first step in this direction is to break down the wall of reserve and independence which characterizes mining operators, a condition surviving the old days when the state was in the making, and there were no interests adverse to mining which had to be met.

Alcalde Mine (Kenosha or Seven Thirty). Operation on a small scale was continued through 1920. After it was found that the old mill and hoist on the property were worn out and inadequate, a 10-stamp mill, hoist, etc., were moved to the mine from the Golden Gate property. Small finds of "high grade" were reported from time to time. The largest of these, found early in September, was said to contain several thousand dollars.

Allison Ranch Mine. No valuable ore bodies have been found in the property by the present company, although a large sum has been spent for exploratory crosscuts during the past two years.

Champion Mine. North Star Mines Company. This mine, 1 mile from Nevada City, was closed the first of July, 1920, after having been operated several years without profit. The Champion produced in 1919 $261,546, at a cost of $250,450 for operation and $25,053 for develop-

ment. The closing of this property left the Nevada City district without a single producing quartz mine.

Delhi Mine (Consolidated Mine). Four miles north of North Columbia. After several attempts to reopen the mine in recent years, work was begun late last fall to use the water for generating electric power to sell to a local power company. The mining company has 14 miles of ditch and rights to 1200 miner's inches of water which can be delivered under 263 feet head.

Empire Mine. Because of its strong financial condition and the high grade of ore, this company has been able to continue work at full capacity throughout the year, except for curtailment caused by the power apportionment. Operations have been consolidated by adding 20 stamps to the Empire mill and abandoning the Pennsylvania mill. Ore from the Pennsylvania mine is now taken to the Empire mill by electric tram.

Grass Valley Boundary Mines Company, M. J. Brock, superintendent. The property is in the western part of the town of Grass Valley, and comprises about 30 acres. There are some old shallow shafts on the property, which have been cleaned out. Specimen ore was reported in the bottom of one of these at a depth of 100 feet. A five-stamp mill and a vanner were put up during the summer of 1920, and some rock from the dumps and from the shaft was milled.

Idaho-Maryland Mines, J. A. Fulton, manager. The main shaft was unwatered to the 1000-ft. level early in 1920, and it was believed that the work of cleaning out the lower levels would be under way before the end of the year. However, the curtailment of electric power delayed work and the lower workings have not yet (January, 1920) been unwatered below 1400 feet. Some progress has been made in clearing the levels above 1000 ft. A 20-stamp mill has been moved from a neighboring property owned by the same company and some ore taken from the old upper workings by tributers has been milled. The company has bought the Eureka and Roannaise properties since the last report.

Le Duc Mine is 2 miles southeast of Grass Valley. The Le Duc Mining Company has been prospecting this property for eleven years in a small way, but to date have found no pay shoots, although about 4,000 ft. of drifts and crosscuts have been driven. There are five veins on the property, but these are covered by andesite on the northern portion. The Alta gravel channel also crosses the property.

Norambagua Mine. Three Sevens Mining Company; K. R. Pell, secretary, 452 Fifth avenue, New York City. Mine is 4 miles south of Grass Valley, near the Auburn highway. The property was worked during 1919 and the first four months of 1920. The vein here averages only seven inches in width, strikes N. 30° E., and dips east 12 degrees near the surface, but steepens to 33 degrees in depth. Both walls are hard granodiorite. When the mine was visited late in 1919 the Oriente (main) shaft was 1100 feet deep on the dip of the vein, giving a vertical depth of 414 feet. When visited in October, 1920, the plant was

closed, but the shaft was said to be down to 1300 feet. The vein was stoped out above the 500 level by former operators. New levels called 600, 800 and 1000 levels were opened in 1919 and 1920, and each of these was drifted several hundred feet. There is also a drain tunnel called Campbell Adit, 900 feet long. The Redmange winze from this adit level is 350 feet north of Oriente shaft, and is connected with it by a drift on the 700 level. This drift is said to be on a new vein which is 20 feet from main vein at the Oriente shaft. The vein carries very fine free gold and auriferous pyrite and arsenopyrite. The ore in the shoots was high grade, carrying sometimes as much as $100 a ton.

During the early part of 1920 the property was equipped with a new mill, containing twenty 1250-lb. stamps and 4 Wilfley tables, and a complete mine plant, including hoist and compressor, all supplied with electric power. The mill was run only a few days in April and the results were reported unsatisfactory. Following this the property was closed.

Normandie-Dulmaine Mine. Leased to Normandie Mining Company, with which are identified E. A. Featherstone, Mack Sennett, A. B. Greenwald et al. The property comprises 102 acres in Deadman's Flat district, 3½ miles southwest of Grass Valley.

Desultory work has been done here for the past two years. There is a small mill on the property. Three veins have been worked in the past through shallow shafts and cuts. The veins carry some small bunches of free gold and auriferous pyrite, chalcopyrite and galena. Lately, work has been planned in search of the Alta gravel channel, which they think extends across the property.

North Star Mines. North Star Mines Company, Grass Valley district; A. B. Foote, manager.

This property has been operated at about one-third capacity during 1920, only 20 stamps of the 60-stamp mill having been in use most of the year. At the end of 1920 only about 110 men were employed, as compared with a full crew of 350 in normal times. Several reasons were given for reducing their operations. First it was felt that many of the miners were not doing a full day's work. It was also claimed that the company was unable to get miners for development work at wages they could afford to pay. Being unable to break enough ore to keep the entire mill running, it was necessary to drastically reduce the force in all departments. During 1918 and a large part of 1919 no development work was reported. The gross production for the fiscal year ending in April, 1920, was $917,999. After paying all expenses and writing off the annual allowance for depreciation of the plant and depletion of the mine a net loss of over $134,000 was reported for the year's work. The cost of producing an ounce of gold at this property is said to have increased from $9.51 in 1913 to $18.04 in 1919, and was still increasing at the end of the latter year, as evidenced by the following figures for the cost of mining and treating a ton of ore:

Total cost per ton treated—
1914, $4.94; 1917, $6.70; 1918, $7.80; 1919, $7.94; last six months of 1919, $8.40.

About the beginning of 1921 the scale of operation was increased somewhat. The lowest level is at 6300 feet on the dip of the North Star vein, or 2500 feet vertical depth. On this level the North Star vein

meets the west-dipping "X" vein, which seems to be going down. The stoping during the last two years has been on the 3400, 4000, 4700, 5000 and 5500 levels principally.

The tailings excavator described in the last report was not a success, and the course of Wolf Creek past the cyanide plant has recently been changed to leave room for tailings storage adjoining the plant.

Red Ledge Mine. Washington district, 3 miles from Washington, near the Nevada City road.

This mine has a record of producing considerable coarse crystallized gold in past years. During the war the owners ceased gold mining and produced a large amount of high grade chromite from the property. The search for gold has been resumed since the price of chromite fell. An old lower crosscut has been extended during the past season, and a little high grade ore has been reported. There are a small mill, compressor and hoist on the property. The mine is owned by Williamson Brothers of Washington, and is being operated now under the direction of Lewis Hind.

St. Louis Mine (Neversweat Mine) is in Willow Valley district, three miles from Nevada City. H. H. Estee, manager.

Considerable new work has been done during the past year. Years ago an ore shoot 200 feet long was stoped from the old tunnel level to the surface. The ore carries a good deal of silver. Estee moved a 10-stamp mill from the old Jenny Lind gravel mine to the St. Louis mine during the past summer and was prepared to begin milling in the late fall.

South Star Mine. South Star Gold Mines Company, A. W. Johnson, president. The property comprises the South Star and Mill Site patented claims and Sumner and Alta locations, in Rough and Ready district, sections 30 and 31, T. 16 N., R. 8 E., 3 miles from Grass Valley.

There are three old shafts on the property which yielded a little specimen ore years ago. The present company has cleaned out the old workings and has done some prospecting to a depth of 100 feet in two of the shafts, one of which they plan to sink deeper.

Sultana Mine. Grass Valley district, adjoining the Empire mine. The 20-stamp mill at this property was in operation during part of 1920.

DRIFT MINES.

Alta California Gravel Mine. Rough and Ready district. Work has continued on a small scale at this old mine during 1920 and a small production was reported.

Alta Combination Mines Company (Baltic Gravel Mine). H. L. Ostrander et al. The property is in sections 20, 29 and 30, T. 16 N., R. 8 E., 3 miles west of Grass Valley. The tunnel used years ago to work the Baltic quartz vein was being cleaned out during the past summer. It is planned to extend this tunnel in search of gravel.

Gold Lead Placer Mines. North Bloomfield district. Oscar Coflin, superintendent. Covers old claims formerly called the Hawkeye and Renown, which were producers years ago. There is an old tunnel about 1400 feet long and some drifts in rim gravel.

During the summer and fall of 1920 some of the old works were being cleaned out and a camp was being established, in preparation for exploring the channel.

Penn-California Mining Company. C. L. Walther, president, Woodlawn, Pennsylvania; A. W. Hoge, general manager, Nevada City. The property is in Willow Valley district, 3 miles from Nevada City by road, at an elevation of 3000 feet. The property is a consolidation of the Doolittle, Lone Star, Cold Springs, Buckeye, West, South and East Buckeye, Montana, North Montana and Montana Extension, Willow Valley and Fountain Head claims, containing in all 948 acres, of which all save 25 are patented. The Doolittle, Cold Springs and Fountain Head are drift mining properties and the Buckeye-Montana-Willow Valley group are quartz claims. The first named have been partially opened and mined, and the latter group has been prospected and mined through a number of shafts, as described in our past reports.

The company has been driving a new bedrock tunnel starting about 1000 feet east of the Cold Springs tunnel, which is said to be the most easterly of the old workings on the main Harmony Channel. This tunnel has been driven probably 1500 feet by the end of 1920; when visited late in May, 1920, it was 1250 feet long. It is in granodiorite all the way. About 1200 feet in, a raise was put up 55 feet to the west, and a drift run 165 feet. Raises from the latter broke into old workings which were badly caved but are connected with the surface through an old inclined shaft. These old workings are supposed to have been run by a man named Doolittle, who is said to have mined a channel 80 feet wide for a length of 200 feet. It is not considered by the operators to be the Harmony Channel; it is reported that two channels were cut in the Cold Springs tunnel and this is thought to be the smaller of the two. The course of the main Harmony Channel is not definitely known after leaving the Cold Springs property, so the exact distance the new tunnel will have to be driven before striking it is problematical; A. W. Hoge estimates the tunnel will have to be 2150 feet long.

The property is equipped with a 50-h.p. motor, air compressor of 2 drills capacity, a mill containing 2 rock breakers and fifteen 900-lb. stamps; there are 1500 feet of T-rails and a few ore cars in the tunnel and a blacksmith shop.

Union Mine. Chris Jorgensen, operator. It lies in Relief Hill district, 4 miles from North Bloomfield. This old producer has been worked on a small scale by Jorgensen in recent years. One monitor is used in washing the gravel brought out of the tunnel. Jorgensen met accidental death at the mine in February, 1921.

There has been considerable work done in the You Bet, Red Dog and Quaker Hill districts in the past three years, but water supply and labor conditions have not been favorable, and as far as known there has been no recent production.

The Quaker Hill Mines Company did considerable work in 1920.

The You Bet-Red Dog Gold Mines Company has been preparing for hydraulic mining, and has procured permits for hydraulic mining.

Work has also been done clearing the old Nevada Tunnel at Red Dog. Lately this company transferred its lease, covering about 1300 acres, to Sydney B. Wood.

HYDRAULIC MINES.

Liberty Hill Mine. William Maguire, owner. W. S. Bliss et al., lessees. The mine is 6 miles from Dutch Flat, on the west side of Bear River. After the mine had been equipped and ditches and reservoirs had been repaired, a few short runs, amounting in all to less than a month's work, were made during the past two seasons. The water supply, particularly last year, was insufficient to permit much piping. Mining was resumed in the winter of 1920-1921.

Omega Mine. This property is 3 miles southeast of Washington. Theodore Larsen continues the operation of the mine on a small scale.

PLACER COUNTY.

Clay of various grades, chromite, coal, copper, gold, granite, limestone, marble, quartz, and iron have been produced here in commercial quantities. A little asbestos has been produced and magnesite and ocher have been prospected. Silver occurred with the gold in the veins in the Ophir district and on Duncan Hill but has never been mined separately. Molybdenite has been noted in different granodiorite areas, usually remote from the railroad.

CHROMITE.

Dan Sullivan of Alta has shipped several carloads of high grade chromite from Alta during the past summer. The chromite was mined about ten miles from Alta and had to be packed part of the way.

There is considerable good quality chromite still available in this county but market conditions have not encouraged mining it.

CLAY.

The clay resources of the county have been discussed in this Bureau's Preliminary Report No. 7 "The Clay Industry of California," published in January, 1920, which may be had free from the main and branch offices. Placer's clay resources are only partially developed and railroad facilities offered by the two lines of the Southern Pacific Railway are favorable for the expansion of the industry.

COAL.

Lignite was mined at and near Lincoln thirty to forty years ago and was shipped to Sacramento where it was retorted for the gas it contains. These lignite beds are rather wet and required considerable timbering.

Lincoln Clay Products Company owns land 1 mile from Lincoln which is partly underlain by lignite. Drilling has revealed two bodies of the lignite, lying at depths of from 48 ft. to 70 ft. below the surface. The lignite beds are from 7 ft. to 15 ft. thick with a pink clay roof and blue clay floor. The beds are nearly flat and the lignite is similar in origin and character to that in Amador County. Old shafts and caved ground on this property indicate that an area of perhaps 6 to 8 acres has been mined. The competition of other fuels and the increasing cost of labor and timber are said to have caused suspension of operations. There were other old workings directly under the town of Lincoln.

COPPER.

The foothill copper belt traverses the western half of the county. There has been no copper mining here during the past year, although there were formerly producers at several localities, particularly in the foothills east of Sheridan and Lincoln, near Ophir and a few miles northwest of Clipper Gap.

GOLD.

This county's drift and hydraulic mines particularly have been heavy producers of gold. The recorded production of about $32,500,000 in the past 40 years, together with an equal or greater amount produced in the 30 years preceding 1880, came chiefly from surface placers, drift and hydraulic mines. It was stated in 1868 that the mines within rifle shot of the express office at Forest Hill had produced at least $10,000,000.

In spite of such a splendid past history, there has been comparatively little gold produced in Placer County for several years, and most of that produced has come from one dredger on American River and one quartz mine in the Ophir district. Conditions prevailing in recent years have been unfavorable for all forms of gold mining, and particularly for the investment of considerable sums of money in mining. Placer County has many drift, hydraulic and quartz properties which offer fair promise to anyone equipped with sufficient money and experience to carry development to a conclusive point. Few of the quartz mines have been opened to depths greater than 600 feet.

QUARTZ MINES.

The history of the county's quartz mines has never been adequately covered; but the aim of the State Mining Bureau is to keep in touch with current mining development as well as to record past operations. As little quartz mining has been done in the county in 1920, only a few properties are mentioned. Some notes on mines not previously covered in detail are included because they have been the subject of inquiry during the past year.

Booth Mine. Slosson and Spinney Estates. Address E. P. Slosson, Auburn, California. Located on Duncan Hill in sections 8, 9, and 16, T. 12 N., R 8 E., about 2 miles by road from Auburn. Comprises 10 acres, patented, covering 338 ft. in width and 1600 ft. on strike of vein.

The vein strikes a few degrees north of west and dips 62° S. It has an average width of 40 inches and is a solid quartz vein, filling a fissure in amphibolite and diabase near the surface but probably passing into diorite or granodiorite in depth. The Booth vein appears to be the east extension of the Bullion vein. This mine was located about 1871. There is a shaft 180 ft. deep on dip of vein and 4 levels were opened at 40, 70, 90 and 150 ft. deep. The vein was drifted 240 ft. west and 150 ft. east on 40 ft. level, 92 ft. east and 26 ft. west on 70 ft. level, 25 ft. east on 90 ft. level and 25 ft. east and 98 ft. west on 150 ft. level. The past production reported as amounting to over $60,000, came from the shaft, from the surface, and from about 50 tons stoped near the shaft to a depth of 90 feet. Slosson reports numerous high assays from the vein in place, notably $39 a ton from the 70 ft. east drift and an average of $12 a ton for 46 assays, included in which were 12 assays from the 150 level. These included the vein as it came; some spots are rich in galena and pyrite. An average not including any specimens is thought to be $4 gold, $1.50 silver and $4 lead and copper (at pre-war prices). No zinc or antimony was reported. There are said to be 4200 tons ready to stope between 150 level and surface, as soon as the water is pumped. Property is equipped with a small engine and pump and

dwelling. A water ditch and electric power line cross one end of the property.

Centennial Mine. Wm. Walsh, Auburn, owner. Contains 10 acres, covering 1600 ft. of vein, in section 17, T. 12 N., R. 8 E., on Duncan Hill, 2 miles southwest of Auburn. The vein is about 30 inches wide but pinches down at intervals and fills a fissure between a hard footwall and a heavy hanging wall, both of amphibolite schist. It strikes N. 80° W. and dips 70° S. and has been proven over the length of the claim by 11 or 12 shafts. After these shafts were sunk, a tunnel was started and was driven the whole length of the claim, evidently with the idea of milling the whole vein. This tunnel was in two sections, 900 ft. and 700 ft. long, connecting a few feet apart vertically, with one of the old shafts. A heavy gouge, said to be 10 ft. wide was encountered on the hanging wall about 300 ft. inside tunnel, as a result of which the tunnel is now badly caved.

The production at this property was from the shafts, which were sunk to about the tunnel level (180 ft. below outcrop). The ore occurs in small rich shoots, 2 ft. to 50 ft. long, and the formation of these rich bunches appears to be influenced by "iron crossings," the miner's term for zones rich in pyrite and chalcopyrite in the amphibolite. These zones dip east, and the rich shoots, lying in the intersections of the iron crossings with the vein, pitch east and are said to cross the vein diagonally from hanging wall to footwall in their downward course.

A winze put down 80 ft. from the portal below the tunnel level is said to have yielded several hundred dollars, tending to indicate that the pay continues.

The quartz near the rich bunches is a greyish, dead looking rock carrying only a little pyrite. The estimated average value of the ore in the rich shoots was $8 to $12 a ton, but the vein as a whole is low grade, considering present costs of operation. The Centennial is credited variously with a production of from $150,000 to $400,000.

Conrad Mine. Wm. Walsh, Auburn, California. The mine is in section 17, T. 12 N., R 8 E., 2 miles from Auburn, a few hundred feet south of Centennial Mine on Duncan Hill.

The claim covers about 1200 feet along the vein, and like the Centennial was worked at times from 1868 to 1890. The vein dips 40° to 50° south and is parallel to the Centennial. It averages about 2 ft. wide but pinches down at places. It lies between amphibolite walls.

The mine has been worked through a tunnel 784 ft. long (180 ft. below outcrop) which is open all the way, and shafts have been sunk from the surface and raises put up from tunnel level wherever pay was found. There is a winze about 60 feet below tunnel level, but it is said to be off the pay shoot. The largest pay chimney was found 30 ft. above the tunnel and yielded $15,000. The property is credited with about $50,000 production.

The ore resembles that in the Booth more than the Centennial, and is said to run from $4 to $8 a ton away from the rich chimneys.

Crandall Mine. Owner, T. F. Jull, Auburn, California. Lessee with option, Unitania Mining Company. Property comprises Cox and Denton patented claim 300 ft. x 1400 ft., Sacramento (agricultural patent) 230 ft. x 1320 ft., and North Star and Florence May locations,

2 full claims in section 8, T. 12 N., R 8 E., on Duncan Hill adjoining Booth mine on the west, and two miles from Auburn by road.

The Crandall tunnel has been driven 410 ft. on the Crandall (Cox and Denton) vein; a shaft has been sunk 90 ft. from the surface and a winze has been sunk 65 ft. from the tunnel, giving a depth of 245 ft. on this vein. The vein pinches and swells, but runs about two feet wide. It appears to be in line with the Booth vein, but there is a break at the end of the Booth; this may be only a surface slide. Other smaller veins called the Hunter and Sacramento average about one foot wide. Hunter vein has been opened by a shaft 85 ft. deep and a tunnel 200 ft. long. Sacramento vein has a tunnel 75 ft. long.

Eleven of the small pay chimneys typical of the mines of Duncan Hill are said to have been found in a length of 400 ft. on the Cox and Denton vein. To a depth of 30 feet the ore milled gave $16 a ton; below that depth it is said to have averaged $6 a ton. Concentrate assays $55 to $100 a ton and makes up 2% to 4% of the ore. The same mistake has been made in the past at the Crandall as at other mines in the district, namely the attempt to mill the entire vein. In view of the fact that payable ore has been found at mines nearby at depths twice as great as those so far attained in the Crandall and other mines mentioned above, it appears entirely possible that such ore may be found in depth here. It has been claimed that the Booth and Crandall vein is the same as the Bullion vein worked in the Oro Fina Mine. This is quite probable but has not been proven, as the outcrop can not be traced continuously, and there are several parallel veins at both ends of the system.

There is a mill of five 1200-lb. stamps, a 10″ x 14″ Blake crusher, an old Deister concentrator and a 12-h.p. Bull Dog gas engine, on the property. There is an electric power line 800 feet distant and water for milling is available.

Canada Hill Mines. Henry Snyder, E. Armstrong, et al., Nevada City, owners. Metals Exploration Company, lessee, 120 Broadway, New York City. The claims are in Canada Hill district, in section 9, T. 15 N., R. 13 E., 24 miles by road from Forest Hill and 44 miles from Auburn. Elevation 6225 feet at Beauty shaft. There are two groups of claims, called Beauty Group, containing 10 claims and Nob Hill Group of seven claims, each covering 4500 feet on the strike of the veins.

A shaft was put down 30 feet on the vein on the northeast end of the Beauty claim, and an upper tunnel was run about 200 feet. These are said to have exposed a vein of quartz 1½ to 3 ft. wide, striking northeast and giving a good prospect. During 1919 and 1920 the lessee drove a lower tunnel 800 feet westerly and northwesterly to strike the vein below the shaft. This is a crosscut for 600 feet. It struck heavy ground about 650 feet in and follows a crooked course thence to the face. The face in October, 1920, showed a few narrow quartz stringers and a gouge one foot thick. The property was idle at that time.

Several prospect tunnels have been driven on the Nob Hill claims There are several outcroppings of quartz here, varying in strike from N. 10 W. to N. 20 W. These veins were of fair width and assayed well on the surface.

There is a good building near the Beauty claim and a 5-h.p. gas engine, blower, two ore cars and 800 feet of track at the lower tunnel.

Elizabeth Mine. John Watson, Penryn; lease and bond to E. C. Montgomery of Auburn, and others. This old mine is at Stewarts Flat about one mile east of Penryn by road, on Secret Ravine. It consists of one fractional claim.

The vein is quartz, 12 to 20 inches wide, strikes N. 7° E., and dips nearly vertical. It was opened in the early '60s to a depth of about 120 ft. and the vein is said to have been drifted 380 feet in good pay ore, which kept a 5-stamp mill in operation from 1862 to 1864. Both walls of vein are granodiorite. The quartz carries 1% to 2% pyrite and galena. A cyanide plant was put up on the property about 25 years ago and ran long enough to treat ore from the old dump, but this company is said to have broken up without having taken any ore from the mine.

A small headframe has recently been erected and a pump and gasoline engine have been installed. The shaft has been cleaned out and unwatered to a depth of about 90 ft., after considerable difficulty, as it is in a good sized drainage basin. It is hoped the old workings will soon be cleared and the vein prospected.

The surface of this district was rich placer ground and the adjoining Chicago Quartz Mine was worked to a depth of about 600 feet.

Oro Fina Mine. Oro Fina Mining Company. Haines Gridley, secretary and treasurer, Auburn, California, is in charge of the mine, which is in Ophir Mining District, in sections 7 and 8, T. 12 N., R. 8 E., about four miles by road west of Auburn. The property contains 96 acres, patented, covering about 4500 feet along the strike of vein. The vein pinches down in places, but runs as a rule about 2 ft. wide, having a width of 16 inches where it enters the granodiorite on the 700 level. It strikes a little north of west and dips 65° S. Both walls are amphibolite in the upper levels. The mine is near the granodiorite contact, but work on the 700 level has not gone far enough to show whether the granodiorite is the main dome lying to the south, or is a dike branching from it. The vein appears to continue into the granite without lateral displacement or loss in value.

The new shaft on Bullion No. 1 claim is 730 feet deep on an angle of 72° in the hanging wall. Six levels are open, called 200, 300, 400, 500, 600, and 700 levels. This company began work in 1913 and sank all this shaft but 50 feet. It connects on 300 level with the old Bellevue shaft, 312 ft. deep. No. 2 level is open 1080 ft. east and 130 ft. west; No. 3, 1400 ft. east and 800 ft. west; No. 4, 1250 ft. east and 200 ft. west; No. 5, 300 ft. east and 500 ft. west; No. 6, 900 ft. east and No. 7, 100 ft. east.

Ore shoots have been worked on both sides of shaft, for lengths of 150 to 250 ft. The vein just west of shaft was of low grade, but apparently not cut off, in the contact zone between 600 and 700 level, at the granodiorite contact. It is said to be of good grade in the bottom, where it passes into the hard granodiorite. East of shaft, No. 7 level must be driven several hundred feet to strike the large ore shoot worked above the 600 level. This region is still well above the contact zone. The vein carries a small amount of sulphides, averaging 1% pyrite, worth $60 a ton.

The mine is equipped with an Ingersoll Rand Imperial air compressor, capacity 600 cu. ft. of free air a minute, operated by 100-h.p. motor, hoist with depth capacity of 1200 ft.; operated by 50-h.p. motor, drill sharpener and oil fired forge. There is a pump with capacity of 200 gal. a minute on 500 level, one of 150 gallons capacity on 300 level and a sinker pump on 700 level.

The mill was built in 1915 and contains rockbreaker, ten 1000-lb. stamps dropping 6½ to 7 inches 100 times a minute, and one each Deister sand and slime concentrators. The capacity of mill is 35 to 40 tons in 24 hours.

A comparison of costs of operation (not including any charges for depreciation of plant and depletion of ore), for the years 1916 to 1919, inclusive, shows the constantly increasing weight of those conditions that have forced or hurried the closing of nearly every mine with low or medium grade ores in California.

Operating Costs at Oro Fina Mine, 1916-1919.

(Courtesy of Haines Gridley.)

Costs per ton mined	1916	1917	1918	1919
Mining	2.92	3.37	4.44	4.52
Milling	.79	.95	1.04	.99
Concentrating	.12	.10	.11	.13
Other costs (pumps, insurance, etc.)	.85	1.25	1.25	1.57
Total, exclusive of development	4.68	5.67	6.84	7.21
Development	.87	2.18	.58*	None done
Total operating cost	5.55	7.85	7.42	

*Very little development done in 1918; no development done in 1919.

Timber which cost $14 a thousand feet in 1916 now costs $43. The price of electric power has been raised repeatedly. First there was the 20% surcharge. This was followed by a raise of ¼c per k.w.h. On top of this, another 15% increase was levied. It is said to cost $68 a month now to run the pumps, hoist the skip occasionally, and satisfy the "stand by" charges.

This mine has produced about $430,000 in the past five years. The property was closed down on December 31, 1920, but underground work was resumed in February, 1921.

Rising Sun Mine. Rising Sun Consolidated Gold Mining Company has a lease and option to purchase; John Zeeman, president; E. C. Klinker, manager. The mine lies in section 33, T. 15 N., R. 9 E., about a mile and a half west of Colfax, by road, at an elevation of 2300 feet. Property includes the Rising Sun patented claim 3000 feet long, and other patented land; total 440 acres.

The vein, which averaged 18 inches wide in the upper levels, but is wider in the bottom, strikes northeast and dips 85 degrees south to the 7th level, where it rolls over and reverses its dip in 20 feet. Below this roll, the vein increases in width and becomes softer. Above the 7th level, vein was said to have been extremely hard in the old workings.

It lies between hard diabase walls.

The mine was opened in 1866 and was operated until 1874 with a 5-stamp mill, and from then till 1880 with a 10-stamp mill which crushed 12 to 15 tons of ore a day, six days a week. The deepest shaft is 749 feet deep, and there are ten levels. There are two other shafts west of the above, one sunk to the fifth level, the other to the third. Levels are said to have been driven about 150 feet west and 400 feet east of main shaft. On west of shaft there was a pay chimney about 40 feet long which was so rich in free gold on the first four levels that the gold is said to have literally held the quartz together. A north and south crossing apparently bounded the rich ore on this side and had probably influenced its deposition. East of shaft the pay was in stringers. The production under previous operators was over $2,000,000. The mine has been idle since 1884 until 1919, when the present company began work.

The workings had been completely unwatered early in the summer of 1920. A new headframe, compressor, hoist, and electric motors have been put in, and a new ten-stamp mill has been installed. The company is capitalized for 250,000 shares of a par value of $1 each.

Snowbird Mine. Nevada-Pacific Exploration Company, N. K. Cooper, president, 319 First National Bank Building, San Francisco. The property is near Sugar Pine Mill, on the Forest Hill Divide.

The serpentine and peridotite belt passing through this region in a northerly direction is characterized by the occurrence of free gold, sometimes in attractive quantities, but often in a talc or talcose schist gangue, from which its recovery is a problem requiring a plant beyond the means of the average owner.

The above company has put up a 50-ton plant the past summer and has opened the property to a depth of 175 feet. They are said to have made a small production from high grade ore and there is said to be a promising showing in the lower workings.

DRIFT MINES.

Big Dipper Mine. McGeachin Placer Gold Company; lease and bond to Stanislaus Development Company, 1321 Baker Detweiler Building, Los Angeles; A. D. Hadsel, superintendent at mine. Contains 165 acres, 3½ miles by road from Iowa Hill and 12 miles from Colfax.

The property includes the Irish and Bryne claim, and Harmon claim, both patented. The old deep channel was supposed to have been worked out years ago. Mr. Hadsel believed there was a section of it left, where the channel turned and old works passed over it. He has done considerable work in the past 3 years including a long cut made with a drag-line scraper, and some prospect shafts. Several thousand cars of gravel from terraces off the old workings have been washed. Two to four men are employed part time.

The property is equipped with an old plant operated by water power. There are a rock breaker, grizzly, ten 950 lb. stamps, 24-inch, 36-inch, and 72-inch Pelton wheels, air compressor (capacity 2 drills) 700 ft. pipe line, drag line scraper and old buildings.

Blue Eyes Mine. S. S. Caples, and Mrs. Ella Caples, Sacramento, owners. Blue Eyes Syndicate, comprising F. A. Moss et al., have a 35 years lease with option to purchase. The property contains about

2800 acres and covers four miles along a ridge covered by andesite and glacial debris, lying northwest of Duncan Canyon, 20 miles by road and trail (2 miles trail) from Westville.

Unusually early snow and an impassable road prevented a trip to the property last October. A new section of road will be open next season which will greatly benefit the mines east of Canada Hill.

The property has been worked in a small way as a hydraulic mine. Moss's efforts have been confined to the development of a drift mine. A prospect tunnel 5 ft. x 6 ft. had been driven 800 feet in October, 1920, on the Gold Dollar claim. Gravel was first encountered in the present works in August, 1920, and was found to prospect well in gold. A small crew of men was employed and supplies were taken in to permit working through the winter. Cost of tunneling is reported at $3.50 to $4 a foot in soft ground and $8 to $10 near the face, in lava. A winze put down 55 feet near face of tunnel is in lava ash the first 35 feet and in fine gravel for 20 feet, with considerable water coming in. The tunnel will be driven ahead, as it is thought they are now crossing a deep hole and will bottom the channel ahead.

The channel is supposed to course northwest. The bedrock is slate and hard quartzite and quartzitic sandstone. The pay gravel is believed to be 50 ft. to 60 ft. wide. The tunnel is at an elevation of 4650 ft. but the property extends along the ridge to an elevation of 5800 ft. Water has not been brought in yet, but can be obtained from Spruce Cañon in sufficient quantity. By putting in a pipe line water could be taken from Spruce Cañon to Duncan Cañon giving a fall of 800 ft. for generating power. F. A. Moss, superintendent, Michigan Bluff.

Carmack Placer Mines (formerly called **Pacific Blue Lead Mine).** George W. Carmack, Seattle, Washington. The mine comprises 350 acres in sections 4 and 5, T. 15 N., R. 13 E., 24 miles by road from Forest Hill via Westville, or 44 miles from Auburn, at the head of Big Secret Cañon at an elevation of 6200 feet.

The probable course of the channel is west, but work done to date has not been sufficient to give an adequate idea of the dimensions, direction, or character of the deep gravel channel believed to exist here. Leo Harris, a former operator, drove an adit 350 ft. east from near the buildings and this adit, which is caved most of the way now, is said to have crossed above a section of deep channel which has not been bottomed. Through this portal he worked a bench or remnant of free white quartz gravel, 20 ft. by 60 ft. in area and 2 ft. to 4 ft. deep and evidently from the rim. This is well above the deep gravel and is possibly part of an earlier channel that has been cut by the deep gravel. The willow-covered flat between the house and county road seems to be worth prospecting for more of this older gravel.

Beside the creek, in a place where the chert, slate and quartzite rims are only a few hundred feet apart, Carmack has sunk an incline 70 ft. deep at 45°. In the bottom of this shaft the volcanic overburden comes down directly upon water-worn chert, seeming to show that the shaft has struck the rim bedrock.

Work was suspended October, 1920, but will be resumed next spring. Property has 2 cabins, a blacksmith shop, one 6-h.p. gas engine, a Gould

pump, cars, rails and tools. There is ample timber and water for mining.

Excelsior Mine. (See Mascot.)

Glenn Mine. Geo. McAulay, A. K. Robinson, Auburn, et al., owners. Leased to Frank Tillotson. It is six miles east of Last Chance on a lava-capped ridge northwest of Duncan Cañon, in the south half of T. 15 N., R. 13 E. The lower workings are in the NW. ¼ of section 34. The road from Westville to Last Chance crosses the property. As originally located the property contained about 650 acres. It lies at about 5000 ft. elevation.

The channel courses southeast and south. The work has been done on the south end of property, on the NW. ¼ of section 34 and adjoining part of section 27, on Grey Eagle and Outlet claims. A total of nearly 8000 ft. of underground work has been done on the mine. The tunnels have encountered a steep channel, interrupted at frequent intervals by falls, where abrupt rises, devoid of gravel, are found. The bedrock is schist and quartzite with pot holes, and the pay gravel, ranging up to 100 ft. in width, is cemented in the bottom and carries some glacial wash. The pay taken out lately has been mined chiefly by two sublessees, who have a piece of ground estimated to be enough for a year's work, and said to carry $5 a ton. Tillotson has had a small crew engaged on development work. The property is equipped with buildings, blacksmith shop, etc. Rich gravel was entered by Tillotson in March, 1921, in the lower adit, but the extent of the strike is not yet known.

Greek Mine. Martin, Burner, et al., of Forest Hill, lessees. On Little Secret Cañon, about a mile by trail from the old Secret House, in section 1, T. 15 N., R. 12 E., and 46 miles from Auburn by road. The Greek mine is supposed to be worked out up to the line of the Macedon property. The gravel channel passing through these two claims is thought to be the same as the one mined years ago in the Black Cañon workings about 8000 feet west. The Greek tunnel was run downstream, and would be out of grade in a distance of about 500 feet farther if continued into the Macedon. The old Greek tunnel, about 600 feet long, and the water right on Little Secret Cañon which has been used at the Greek mine, would be of limited use, therefore, in working the Macedon property.

Macedon Mine. Dr. C. W. Richards, et al., Sacramento, owners. In the southwest quarter of section 1, T. 15 N., R. 12 E., adjoining the Greek mine on the west. This property contains the westward or downstream extension of the channel worked at the Greek mine. The channel here has been worked only where touched in the Greek tunnel. A tunnel started on the Macedon years ago would be too high if continued to the channel.

Mascot Mine (formerly **Excelsior Mining Company**). Haines Gridley, Auburn, is trustee for the owners. The mine is about ½ mile southeast of Forest Hill. This property is thought to still contain 1500 feet of channel on the Blue Lead, which was worked in the Mayflower and Paragon, to the northeast, in years past, at a good profit.

The present operators, for whom Gridley is superintendent, have driven about 800 feet of new drifts and have advanced about 400 feet upstream. They work through the old tunnel. The gravel they have opened has been mostly low grade, and is thought to be in a long hole in the channel.

The property is supplied with electric power from a plant at Horseshoe Bar. Machine drills are used. There is a small stamp mill on the property, but the present company has not crushed much gravel.

Ralston Divide Gravel Mine. California and Hawaiian Development Company, owner; J. S. McCandless, president; office 859 Mills Building, San Francisco. The property consists of about 15 sections, 9600 acres, in townships 13 and 14 N., R. 12 E., and townships 13 and 14 N., R. 13 E., on Ralston Divide, between Long Cañon and Middle Fork of American River. The claims cover a length of about 14 miles. Of the total holdings, 1060 acres are patented and patents for more have been applied for. The mine is reached from Auburn via Michigan Bluff by 30 miles of road and 9 miles of trail; or via Georgetown to Barton's Cabin by 30 miles of road and 8 miles of trail. There is also an old road from Soda Springs station.

The present company has had the property since 1908, and has expended to date probably over $150,000 for equipment and development work on the portion for which patent is being sought.

Geologists and engineers believe that the channel under this property is the extension of the channel mined in the Paragon at Bath. The series of interstratified layers of gravel and rhyolite tuff is 160 feet thick or more, and is much wider than at Bath.

The portal of tunnel No. 1 is in the northeast $\frac{1}{4}$ of section 5, T. 13 N., R. 12 E. This tunnel is 7 ft. by 8 ft. in cross section and about 4700 feet long. About 2500 ft. of drifts and 1000 ft. of raises were run from this tunnel, and 15 diamond drill holes were put up. This work cost nearly $75,000.

Tunnel No. 2 is somewhat over a mile south, a little west of No. 1. It is 145 feet long, with an incline 153 feet long, and a crooked drift about 280 feet long from the foot of the incline.

Tunnel No. 3 begins near the center of the northwest $\frac{1}{4}$ of section 8, T. 13 N., R. 12 E., and has probably reached a length of 1600 feet by this time. It runs nearly northeast; 775 feet from the portal, a raise of 14 feet connects with the drift from the bottom of the incline from No. 2 tunnel. A good deal of this later work is along the channel. No. 2 and No. 3 tunnels are 8 ft. by 8 ft. in cross section.

There is a power house generating 100 h.p. on the lower part of Brushy Creek, from which a power line runs south nearly two miles to supply power for the compressor at No. 3 tunnel and for other needs. There are also blacksmith shops at No. 2 and No. 3 tunnels, sluices and camp buildings. All the above workings and plant are at Ralston's on the western end of the divide.

Besides the above, considerable has been done at the Goggins hydraulic pit, in the southeast $\frac{1}{4}$ of section 22, T. 14 N., R. 13 E. The hydraulic pit here is 500 feet long, 90 feet wide and 60 feet in average depth. A tunnel driven from this pit is 755 feet long in the direction of the channel (NW. and SE.) with about 750 feet of branch drifts. There is also a compressor house and compressor, blacksmith shop,

sluice boxes, camp and hydraulic equipment. The Lambert ditch, 22 miles long from French Meadows on the Middle Fork of American River, can deliver an ample supply of water for hydraulicking. There is an abundance of good timber on the property.

HYDRAULIC MINES.

There was no activity in hydraulic mining in the county during 1920. A little preliminary work was done at the mine named below early last year. This property has never been adequately covered heretofore in the Bureau's reports, and as it appears to be well worthy of attention, some data are given here about it.

Lost Camp Hydraulic Mine. Located in sections 22 and 23, T. 16 N., R. 11 E., 2 miles by road from Blue Cañon at an elevation of 4300 feet. There are 440 acres of patented land in the property, of which about 140 acres is mining ground. Under lease and option in 1920 to J. S. Day et al., trust deed held by E. T. Robie, Auburn.

The deposit contains interbedded layers of rhyolite tuff and auriferous quartz gravel lying on slaty bedrock. The best pay is said to be well above the bedrock. The direction of the old stream was westward. The gravel is free wash, carries no overburden, and the boulders are mostly of quartz and medium sized. A good amount of water is desirable in piping on account of the quantity of tuff in the bank. The ground lies on a bench between Texas Gulch and a branch of Blue Cañon Creek, and there are steep cañons on both sides.

The Slums Cut on Texas Gulch was on the rim on the northeast. It is said to have paid well for ground sluicing. The Miller Cut is on the rim on the southeast and is about two acres in area. It is said to have paid $80,000 for hydraulicking. The Boston Cut on the Blue Cañon side, is estimated to be about 600 feet long, 300 feet wide and 100 feet deep, covering about four acres in area. The total yield of the property is locally reputed at "several hundred thousand dollars," but it has been worked over such a long period by so many different small operators that a definite figure is hard to arrive at. Day made a short test run in the Miller Cut early last year and claims the result was very satisfactory. There is about one-third of a mile of channel remaining unworked between the east and west pits.

The property is equipped with 1500 feet of old pipe from 14 inches diameter down, one giant and a few hundred feet of sluices. A water right on Blue Cañon is owned but the two miles of ditches are in bad shape. Water can be bought during six months in winter and spring from Pacific Gas and Electric Company. The present pipe line gives 100 feet fall, but needs to be replaced. There is ample room for building a series of dams in Blue Cañon Creek for storing tailings. The bedrock cut in Boston Pit should be deepened to give grade for more piping on that side.

GOLD DREDGERS.

There is only one dredger in operation in the county at present. The dredger formerly operated by the El Dorado and Placer Counties Gold Mining and Power Company on the Middle Fork of American River, and the one operated by Lawrence Gardella at the old placer

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mining camp of Virginia, between Newcastle and Lincoln, have both been out of commission several years.

Pacific Gold Dredging Company, 582 Market street, San Francisco, California. The dredger formerly operated by this company near Mammoth Bar on the Middle Fork of American River, finished work there about three years ago and has been moved to the North Fork of the river below Applegate. This dredger is now the principal gold producer of the county.

GRANITE.

Granite quarries were opened at Penryn and Rocklin immediately following the building of the Central Pacific Railroad and were in full operation until 1890. Many of the finest buildings in the state, including several in old San Francisco, were built of stone from these quarries. The demands of stonecutters for increased wages, the competition of manufactured building materials, and other causes, strangled the industry which formerly employed about 300 men.

The Placer quarries are advantageously located as regards transportation, being only 110 to 117 miles from San Francisco, and the stone is pleasing in appearance and of fine quality. That at Rocklin is fine grained and light colored, with only a little of the dark minerals in it. The stone at Penryn is coarser grained and with more hornblende. There is also a quarry beside the road two miles southeast of Penryn, where a beautiful gabbro, locally called "black granite," has been worked in a small way. This stone takes a fine polish and has been used for urns, vases and other larger work.

California Granite Company, Rocklin, has been operating its quarry at Rocklin during 1920. They have been filling an order for granite for the new Bank of Italy Building in San Francisco.

There are a number of small operators at Rocklin who employ one to three men each intermittently on small jobs.

IRON.

Hotaling Iron Mine. John Barnicott, Newcastle, owner. Property is 3½ miles by road west of Clipper Gap.

This deposit was found in 1866 and was worked until 1885, but the principal production was from 1880 to 1885. The ores were hematite and magnetite, containing from 40% to 65% iron. The principal workings were No. 1 shaft and cut, 250 feet deep on a hematite ore body 30 feet wide and 150 feet long, located 100 yards south of the old furnace site, and No. 2 shaft, which was 150 feet deep on a magnetite ore body 50 feet wide and 150 feet long, running 40% to 50% iron. The deposit is near the contact of granodiorite and the altered sedimentaries of the Calaveras formation.

The smelting plant between 1880 and 1885 included a blast furnace with 60-ft. stack and several bee-hive coke ovens, surrounded by a good-sized camp. Limestone for flux was quarried a few hundred feet from the furnace. Wood for charcoal was cut off an area of 25,000 acres adjoining the property. The high-grade hematite was mixed with the magnetite to give an average iron content of 55% in the

furnace charge. The furnace produced 30 to 35 tons of pig iron a day. Except for a period of three months required for rebuilding the plant after a fire, the furnace is said to have been in steady operation for the five years.

The pig iron was of high quality, and brought a price of about $35 a ton. It was used by the Southern Pacific Company for car wheels and axles. The property was closed largely on account of the competition of cheaper Alabama pig iron, which undersold the local product in the San Francisco market. The iron ore is not thought to be worked out, but the grade of ore remaining available would be considerably lower than that heretofore smelted unless new bodies of ore, now unknown, are found. There are several other small iron ore deposits in the vicinity of the Hotaling mine, and when the old furnace was running, the low-grade ores from these were often mixed with the

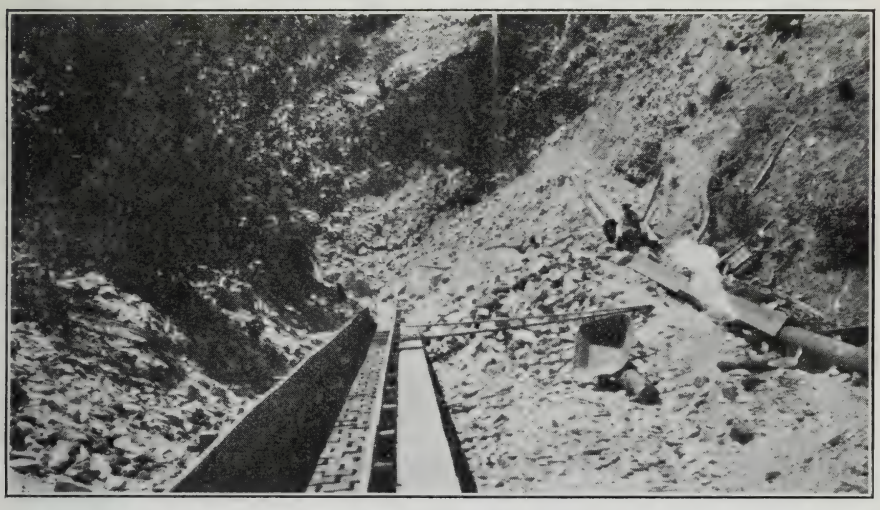

Photo No. 56. Pit and Sluice, Australia Hydraulic Mine, near Spanish Ranch, Plumas County.

higher grade ore from the Hotaling mine and smelted in small quantities.

LIMESTONE.

There are many deposits of limestone in the county, but none of them are being worked at present.

The **Dunlap Property.** Address Boutwell Dunlap, Auburn. This is the westerly portion of the large lens that is being worked by the Mountain Quarries in Eldorado County. This lens is cut in two parts by the Middle Fork of American River. The Dunlap property is on the Forest Hill road, five miles from Auburn. It is the southernmost of a series of limestone bodies that outcrop at intervals to within a mile of Clipper Gap.

Another belt of detached limestone outcrops extends from the North Fork of American River northwest of Butcher Ranch, to Applegate. The most accessible of this group is the **Spreckels**

Deposit, owned by the Spreckels Sugar Company, Spreckels, California. This property is a mile by road from Applegate. It is a good quality gray limestone and has been worked considerably.

There was formerly a lime kiln on a deposit four miles west of Clipper Gap, on a crossroad between the Grass Valley highway and the Colfax highway.

D. J. Sullivan, Dutch Flat, and **Mrs. Cora H. Linder,** 2022 Brush street, Oakland, have a large deposit of good quality limestone in the steep cañon of American River, near Gorge. This rock could best be delivered to the railroad by tram.

MARBLE.

Dark gray marble, with jet black veining, was found near Bear River, two miles west of Colfax, in 1866. This stone takes a high polish and some of it was used for counters and interior work in the early days. It has been idle in late years, but it was reported late in 1920 that some work was to be done on it.

Verde antique, or serpentine marble, has been found in two localities, one near Butcher Ranch, the other in section 1, T. 13 N., R. 9 E. These properties are 8 and 16 miles respectively from the railroad at Auburn and have never been worked.

White marble occurs in small deposits at several places, notably near Auburn and at the old Hotaling iron mine, 3½ miles west of Clipper Gap. Both these deposits have been worked a little.

PLUMAS COUNTY.

MINERAL RESOURCES.

This county is now the principal copper producing district in the state. Its drift and hydraulic mines have produced a great deal of gold in the past, but in common with the gold mines elsewhere in the state, are in a quiescent state, and the gold production for many years past has been dwindling, although for the period 1880-1920 the recorded gold yield has been a little over $18,000,000. Silver is recovered as a by-product from gold and copper refining. During the war manganese ore and a little chromite were shipped, some of the manganese ore having been of especially high grade. The county has entirely undeveloped iron ore deposits and considerable limestone, as well as deposits of industrial minerals, which have received little attention because of distance from possible markets.

Because of the great interest shown in mining and prospecting for copper here in the past few years, most of the writer's time while in the county the past summer was spent in visiting the copper properties and as many as possible of the gold mines which have not been covered in the Bureau's recent reports.

GOLD.

Australia Placer Mine (formerly the **Erickson Mine**). Owned by Australia Placer Mining Company; Wm. C. Wolf, president, Quincy, California. In section 1, T. 24 N., R. 8 E., 3 miles by road from Spanish Ranch.

This property was worked intermittently by Erickson in a small way as a drift mine for 40 years, and was sold to the present company of 20 partners in 1918. It comprises 90 acres, 70 acres of it being patented, and covers $\frac{5}{8}$ mile along supposed course of channel.

The company fitted up for hydraulicking last winter, but ran the giant only 111 hours, as they were interrupted by the logging operations of a lumber company, which has now finished work nearby. The small pit opened on the rim of channel shows loose gravel of slate and quartz on black slate bedrock. The cut was about 40 ft. deep, but gravel is deepening and is not capped. The gravel carries a great deal of pyrite, and finely broken quartz derived from the stringers in the slate bedrock. The upper 15 ft. of bank is brown gravel and balance blue gravel. The company was handicapped by inexperience and the short run made was not enough to prove the value of the ground, as the pay is thought to be principally in the deep channel, within a few feet of bedrock.

There are 800 feet of 22″ to 11″ pipe, 2 giants and 100 feet of sluices on the property. Eight hundred inches of water under 220 feet head is said to be available through 8 miles of ditch, and the company claims this water will be had free of cost for five years. There are new buildings and cabins sufficient for housing a full crew. The property is in well-timbered country at about 3800 feet elevation. Tailings are impounded behind a dam in Wauponsie Creek, which crosses the claims.

Apex and Pensotti Claims. C. M. Root and P. Pensotti, 428 Broderick street, San Francisco, were prospecting in July last near the

summit close to the Quincy-La Porte road in section 29 or 32, T. 23 N., R. 10 E., about 2 miles north of Onion Valley. They had opened some shallow pits on one narrow quartz vein and were driving a tunnel on another. Quartz taken from a small vein near the road had been crushed in a Gibson mill and a little free gold was saved.

Cameron Claims. Owner, R. M. Cameron, Seneca. Three unpatented lode claims on unsurveyed land a mile and a half north of Seneca in the steep cañon of North Fork of Feather River. Stringers of quartz 3″ to 2 ft. wide cross a "formation" 25 feet wide between walls of slate and greenstone. The best pay is said to occur in pockets at the junctions of narrow "iron crossings" with the vein. Cameron has followed the vein for 200 feet in 2 tunnels, the lower of which is about 150 feet below outcrop. He also does some ground sluicing.

Davis Group. Formerly **Smith and Scott Mine.** Owner, Edman Davis, Crescent Mills. Consists of 40 acres of placer ground with 2 overlapping quartz locations, in the NE. ¼ of section 7, T. 26 N., R. 9 E., at an elevation of 5280 feet and 5.6 miles by steep mountain road from Greenville. There is a stand of good pine timber on the claims and the owner was involved in a dispute at time of visit, with timber men.

This is a residual placer resulting from the alteration and weathering in place of diabase, with resultant freeing and breaking up of numerous auriferous quartz veinlets. There is a capping of 1 to 2 ft. of soil covering a layer of pay dirt 1 to 3 ft. thick which carries rough, angular quartz and diabase lying on clay, that has been derived from diabase. This pay dirt covers a large portion of the claims. Some of the gold pieces washed out weigh ½ ounce, and 50 cent pieces are common. The writer panned some of the dirt and judges $1 a yard is a moderate estimate of its value. The gold is rough and angular.

The only water available now for washing is from melting snow in the spring. There are 2 miles of small ditches and 450 feet of 12″ sluice boxes on the claims. A few hundred cubic yards have been worked.

Gianella Claims. Savino Gianella and seven partners, 701 San Bruno road, South San Francisco, have located 640 acres of placer claims in sections 29 and 32, T. 23 N., R. 8 E., adjoining the Greenbower property. A lava-capped channel is supposed to pass through the property, but no work had been done to explore it up to the middle of 1920.

Gold Mountain Hydraulic and Dredging Company of 201 Grant Building, Los Angeles, California. G. W. Fagg, manager, Buck's Ranch via Meadow Valley. Comprises 440 acres 3 miles by road south of Buck's Ranch in sections 14 and 15, T. 23 N., R. 7 E., at an elevation of 5400 feet.

A bed of unassorted, angular gravel 3 ft. to 11 ft. deep, carrying a great deal of sand and silt, and lying on steep bedrock has been hydraulicked over an area of possibly 20 acres and a maximum width of about 700 feet. For several seasons past, mining operations have been limited more than usual by short water supply. Mining is carried on during the spring thaw and the early summer, the 1920 run having been from May 3 to July 7, with 4 men employed and 1000 yards or less moved daily.

There are 2 ditches 3 miles and a mile and a half long, respectively, which carry 300 inches of water and there are several thousand feet of 24-inch pipe which delivers the water under 120 ft. head. In the pit there are two small giants and about 700 feet of 14″ to 8″ pipe and 1500 feet of sluices. There are 6 houses, a blacksmith shop and small sawmill on the property, and a fair stand of pine timber.

Tailings are stored behind a dam in Willow Creek.

Great Divide Mine. Geo. Brunk and Wm. Roddy, of Greenville, owners. The two owners are working an old high stream bar on Onion Creek, a branch of Rush Creek on unsurveyed land about 2 miles downstream from the White Horse Mine. They are reported to have taken out several thousand dollars with rockers and to have found some nuggets, the largest of which was said to be worth $1,446.

Greenbower Mine. Owner, Henry Greenbower, Meadow Valley, Plumas County. There are 18 association placer claims totalling 2880 acres, claimed by Greenbower. The property covers the lava capped ridge extending from Mt. Ararat to the Middle Fork of Feather River, between Willow Creek and Bear Creek and includes parts of township 23 N., R. 7 E., township 22 N., R. 8 E., and township 23 N., R. 8 E. Work lately has been where the ancient channel breaks out on the steep north slope of the river cañon. Here a camp is located and hydraulic equipment has been set up and one test run, the only one ever made on the property, was made last spring. About 1800 feet of tunnels have been driven in this ground; 3 crosscuts 270, 360 and 400 feet were driven in the upper gravel but are said to have been too high, and tenor of gravel in the deep trough is unknown as the water prevented sinking winzes. This is all old work. All except 600 feet of drift are caved. Greenbower states the hydraulic run of about 800 yards made last season gave a return of 70 cents a yard without cleaning up the bottom. This was on the rim, where the gravel is about 50 feet deep. The total width of channel is 270 feet to 400 feet. The rim gravel is tight but not cemented and carries some large boulders. The owner estimates there are 500,000 cubic yards of gravel that can be hydraulicked between the place where channel breaks out and where the lava overburden becomes too heavy to pipe. He considers this a bench and believes there is a main deep channel further in the hill. The claims cover 5 miles of the possible course of channel, which flowed south.

This is virgin ground and appears to offer great possibilities. The owner has been working single handed here for 20 years, but without capital has never been able to adequately prospect it, and the same thing was true with the previous owners. The ground is well located for hydraulic mining. The bedrock elevation in the pit is about 4800 feet and there is a steep slope thence to the river, which flows in its cañon a mile and a half away at an elevation of 2400 feet.

The mine at present has 3 miles of ditch giving a maximum of 550 inches of free water from Little Bear Creek under 80 ft. head. Six miles of new ditch to Willow Creek would give an estimated additional flow of 800 inches and a working season of 4 to 5 months as compared with a present season averaging less than 3 months. There is ample good pine timber on the claims. The camp is reached by 9 miles of road from Bucks Ranch. A portion of this road was built last year.

The trip can be made by auto in the dry season. The mine is equipped with a giant, 200 feet of new pipe and 250 feet of new sluice 2′ x 3′ with an undercurrent, and there is a new house large enough for a working crew.

Jenkins Claim. (Quartz.) G. W. Jenkins, Seneca, owner. This is an unpatented lode claim in the steep cañon of North Fork of Feather River ½ mile from Seneca. The vein, possibly an extension of the Seneca-Eureka, has been only slightly prospected by 2 tunnels 142 ft. and 56 ft. long. The owner works alone.

Long Valley Mine. (Quartz.) Formerly the **Stauffer Mine.** Address J. A. Holley, Greenville, California. Located 6½ miles from Greenville by road in section 6, T. 26 N., R. 9 E., at an elevation of 5250 feet, near top of divide between North Fork of Feather River and Indian Creek. Consists of 4 unpatented claims covering a zone of auriferous quartz stringers on and near the contact of serpentine with micaceous schist and altered intrusive rock. Work on the mine began in 1902. There is an old inclined shaft 250 feet deep giving vertical depth of about 200 feet, and the formation was worked for a length of about 250 feet from this shaft and probably the entire depth of 200 feet; there were 3 levels off this shaft but the old workings are caved and the headframe down. A new inclined shaft was down 65 feet and 50 feet of new drift had been driven at time of visit, to connect with an adit near creek level. There is no defined quartz vein and the "pay" is followed usually by panning, the gold being very fine, and free, as the work is in the oxidized surface zone. About 3 ft. in width of the soft clayey material is payable, it is said.

The mine was formerly equipped with a 10-stamp mill, which operated during 3 years and is said to have produced about $100,000. At present there is a mill of five 750-lb. stamps run by a gas engine. Holley states he has milled between 300 and 400 tons that have yielded $6 to $11 a ton at a probable cost of $2 a ton for mining and milling. There is a good cabin on the property. Three men employed in July, 1920.

Morington Mine (River Flume). Morington Mining Company, 617 Pacific Building, San Francisco; Julius Becker, manager. Reached only by steep trails from Enterprise, Butte County, or from Greenbower Mine via Bucks Ranch, Plumas County. Mine address, Enterprise, Butte County. Officers and employees of The Foundation Company are reported to be stockholders. The property comprises 40 acres, covering 1797 feet along the bed of Middle Fork of Feather River in the steep cañon at and just above Hartmann's Bar at an elevation of 2400 feet on unsurveyed land in T. 22 N., R. 7 E. The deposit is loose wash gravel of unknown depth on hard granodiorite bedrock in the present stream. The manager stated that a diver and a drill used to prospect the ground had not proven satisfactory and that he had no definite information at hand as to gold content. There is a hard reef of bedrock across the stream at the lower end of the claim, that forms a natural dam and the stream bed above this is confined to a narrow rock-bound channel which has never been worked. Just downstream and on higher ground on the north bank, were the rich diggings called Hartmann's Bar.

The project contemplates the diversion of the river at the upper end of the claim by means of a log crib, hydraulic and rock fill dam, the water to be passed thru a wooden flume 9 ft. wide and 6 ft. high and 1797 ft. long. It is planned to lift the gravel from the streambed by a clam shell bucket and wash it in sluices leading from the main flume.

The construction work was being done at time of visit July, 1920, by The Foundation Company, who had erected a good sized camp and were employing 69 men. Water from Willow Creek under 200 ft. head runs an electric generating plant containing a 36-inch water wheel, a 480 volt, 90 ampere alternating current generator, and a 125 volt 16 ampere direct current generator. There are a 150 cu. ft. air compressor, 3 jackhammers and 12 boring machines, and a small saw mill and donkey engine. Timber was being cut on adjacent land in the National Forest.

The dam, on which work had just begun, is to be 120 ft. long on bottom, 160 ft. long on top and 43 ft. high and to rest on a concrete foundation 40 ft. wide which is to fill the inequalities of the bedrock. The bottom section is to be filled with coarse rock and each succeeding section will, under the present plan, be filled by hydraulicking in the loose rock and soil of the adjoining slope. The log crib will be fastened with $\frac{3}{4}''$ x 30″ drift pins and faced with 2 layers of 3″ x 12″ planks placed vertically and lapped. For passing the water during construction, 2 doors 5′ x 8′ for tunnels are provided. After the dam is finished, these are to be closed, and the tunnels to be filled from the downstream side with rock. The spillway will be $107\frac{1}{2}$ ft. long and 15 ft. high.

The niche for the flume was blasted from the solid rock. Approximate specifications for the flume are as follows:

Length 1797 ft. with a drop of 7.9 ft. width 9 ft., height 6 ft. Sides and bottom of 2″ x 12″ planks. Typical cross section shows one 2″ x 6″ top brace and two 2″ x 6″ side braces, and 6″ x 6″ side timbers (4 ft. apart). Floor beams 6″ x 8″ resting on three 6″ x 10″ stringers on 8″ x 8″ cap which is supported by three 10″ log posts which have their bases concreted into hitches in the solid rock. Cracks in floor and sides to be covered with 1″ x 4″ battens. All pine timber. The flume was about half finished July 15, 1920, and there was no probability of actual mining beginning this year.*

On account of the uncertainty and meagerness of data at hand regarding the amount and tenor of gravel in the stream here and the question as to whether or not the water can be controlled and the ground can be worked profitably by the proposed means, considering the hard bedrock and other physical conditions, this appears to be a particularly speculative venture.

Rich Point Mine. (River placer.) Rich Point Mining Company, E. N. Hawkins, Strand Hotel, San Francisco, and Thomas Powers. Located on Middle Fork of Feather River at mouth of Bear Creek in section 35, T. 23 N., R. 8 E. Fifteen miles from Meadow Valley of which 14 miles is pack trail. This property was not visited, but in July, 1920, it was reported the company was preparing to build a barge of 2 inch planks to carry a Diesel engine, 4 inch gravel pump,

* Author's Note. The dam was erected and hydraulic fill piped in November 1. Subsequent high water is said to have torn out one end of dam and washed out the filling.

diving outfit, etc. The trail was being enlarged to a road. They planned to pump the gravel from the holes and crevices in the bedrock of the river channel.

Rogers Mine. (Quartz.) Four miles by steep mountain road from Bucks Ranch in section 14, T. 23 N., R. 7 E., near the Gold Mountain hydraulic mine. The owner, A. L. Rogers, works the claim alone in summer and has a small prospecting mill. He has crushed a few tons of ore said to run $30 to $40 a ton. Property was not visited. Ore is said to be a stringer lead carrying considerable arsenopyrite.

Sanhedrin Mine. (Deep placer.) Sanhedrin Mining Company, A. W. Craig, secretary, 1371 Oak street, San Francisco. Formerly the Star of Plumas mine. In section 8, T. 23 N., R. 8 E., 4 miles from Buck's Ranch by steep road. This mine has not made any production recently although reputed to have paid about 20 years ago. A few men have been working lately. There is a tunnel that has reached a length of 1000 feet. This property is thought to be on the "back-channel" which passes thru the Greenbower mine. Assessment No. 6 was levied on stock in April, 1920.

Seneca Eureka Mine. (Quartz.) Formerly called the **Hazzard Mine.** On unsurveyed land one mile by trail from Seneca on east side of cañon of North Fork Feather River. Owner, C. D. Hazzard, Quincy, California.

There are 13 unpatented lode claims but most of the work has been done on one or two of the claims and none on many of them. The vein is a stringer lead striking northwest and dipping 55° south in the main tunnel but apparently having an anticline, with the vein flat in the third tunnel and the other limb dipping about 45° north, as shown in the fourth tunnel. The footwall is greenstone and hanging wall black slate, and the deposit is similar to the Mother Lode stringer leads in many ways. The maximum width of the vein revealed in the workings is 41 feet. There has been post-mineral movement on the hanging wall.

The vein has been explored by 5 tunnels, all within a few hundred yards of one another, the highest of which is 800 feet long, being a crosscut for 100 feet and a drift on vein the rest of its length, with fissure decreasing in width near face. Four other tunnels lower down expose the vein which pans well in free gold where the pyrite has been oxidized. These tunnels are now open 50 to 90 feet each although one of them was formerly opened for 230 feet. The lowest opening is about 200 feet vertically below the highest and the outcrop of similar vein matter can be traced to the summit of the ridge in the general direction of the strike of the vein; this higher ground has never been prospected. The ridge rises over 1000 ft. above the highest tunnel.

Assays from the vein are reported to run from $6 to $25 a ton. It seems strange no mill test of the vein has been made, as there is considerable quartz available for crushing if it proves to be ore. The content of sulphides is 2% to 4%. There is a small cabin on the claims.

Seneca Consolidated Mine. (Quartz). Formerly the **Del Monte Mine.** Seneca Consolidated Mining Company, J. J. Reilly, manager, Seneca. On the North Fork of Feather River ½ mile upstream from Seneca, at an elevation of 3700 feet.

There is a 4000 ft. tunnel on the property which is said to have encountered only a base vein, carrying a good deal of arsenopyrite, after passing the vein now being mined. Work underground at time of visit in July, 1920, was confined to breaking ore 55 ft. above the Del Monte tunnel, 800 feet in. This stope is about 137 feet below the surface. The quartz was 16 ft. wide in the stope and was broken so badly as to require little powder. It carried traces of copper, some free gold and very little rusty pyrite. The deposit appears to be pockety, with small bunches of rich ore, but averaging low grade.

Some years ago the Del Monte Mining Company sued the adjoining White Lily Mining Company for alleged invasion of ground and won the suit. This resulted in closing the White Lily, then a producer, and taking over their mill by the other company. The White Lily tunnel, about 600 ft. long, drains the immense flow of water which comes in near the face of the Del Monte tunnel, and flows uncontrolled.

The mill of ten 1000-lb. stamps and 2 concentrators was being run one shift, and the manager was not optimistic about the outlook. Four men were working underground and 10 to 12 tons of ore a day were being mined and milled. Electric current for power and lighting is generated by water from the river. The property comprises 1500 acres and there is ample good pine timber on it.

Wheelock Mine. (Quartz.) Leander Wheelock and J. G. Reynolds, owners, Crescent Mills. This is one unpatented claim at the edge of the town of Crescent Mills. A vein with a maximum width of 2 feet strikes west and dips north. It has been drifted on for 50 feet, at a depth of about 25 feet below the surface. It was opened by a tunnel about 200 feet long, 150 ft. of it crosscut. There is also an inclined shaft 55 ft. deep that has not encountered vein, and a winze had been sunk 16′ on the vein in the drift, and a block 20′ x 2′ x 16′ had been stoped.

A Joshua Hendy triple discharge mill with two 880-lb. stamps, to be run by a gas engine, was being installed late in July, 1920. The ore is stated to run from $5 to $30 a ton and a mill run of 30 tons yielded $485, according to Reynolds.

White Horse Mine. (Placer.) James and J. G. Reynolds, Crescent Mills, owners. On unsurveyed land (in what would be section 12, T. 26 N., R. 8 E., if surveyed), in Long Valley district, 8 miles from Greenville by steep road, and at an elevation of 5550 feet.

There are 2 claims, one placer and one quartz, but the placer is probably the more valuable, as the quartz vein has been prospected and abandoned. The placer ground is on the slope near the top of the divide just west of Long Valley reservoir. It is a residual placer, similar to the Davis Group (which see). There is a capping of about 2 ft. of soil underlain by from 2 ft. to 14 ft. of loose, angular residual material carrying gold and lying on the clayey, altered diabase bedrock. The gold is rough and coarse and derived from the disintegrated quartz stringers in the diabase. The greater part of the claim is covered with such material which is thought to be rich enough to work.

Reynolds states 1000 cubic yards which he has ground sluiced has yielded $1 a yard. He has been able so far to work only during the

spring thaw, with water from melting snow. He has a plan for putting water on the ground by pumping into an old ditch and thence into a mining reservoir. This plan, if carried out, would permit 6 or 7 months' work each year. The cost of the equipment for pumping and ¼ mile of new ditch is estimated at $1,500. The water supply would come from Long Valley reservoir. Present equipment is 200 ft. of 12″ x 18″ sluice boxes, some small water pipe and hand tools. The sluice is laid in a tunnel and there is a race 600 feet long.

COPPER.

The copper mines and prospects described below lie in the belt extending from the Walker mine near Mt. Ingalls to and including the Engels group of mines on the north, an airline distance of 17 miles across rugged and mountainous country. The writer visited personally nearly all of the properties where any work was going on. Prospecting here has been encouraged by the development of fine ore bodies in the Engels and Walker mines, which are the principal producers.

Beardsley Copper Prospect. Beardsley Copper Company, A. L. Beardsley, manager, Genesee. In section 14, T. 26 N., R. 11 E., 9 miles by steep Taylor Lake road from Viramont on the Indian Valley Railroad. Elevation 5900 feet. Consists of the Telge Group of nine claims covering 4500 ft. along outcrops striking a little north of east, and Big Injun Group of 5 claims and Copper Bullion claim, covering 3000 ft. north and south on east of Telge Group, in all about 260 acres of unpatented land in Plumas National Forest.

The mill, and most of the work at time of visit, was on the Big Injun claims. Not far from the mill on a steep slope 3 crosscuts have been driven. No. 1 (upper) crosscut is 120 ft. below the outcrop and had been run 198 ft. to the vein, then drifted 50 ft. each way on vein which strikes N. 10° E., and 18 ft. past vein on one end into the hard footwall. This vein dips 60° E. and is 6 ft. wide. There is a raise on vein to surface, 120 ft. No. 2 crosscut, 160 ft. below the outcrop, strikes at a distance of 180 ft. what is apparently another vein carrying very finely disseminated chalcopyrite and bornite. No. 3 crosscut is a little over 200 ft. below the outcrop and at a distance of 50 ft. from portal cuts a vein 9 ft. wide, which is evidently the same one found in No. 2. No. 3 crosscut was in 268 ft. at time of visit, and still had a little over 100 ft. to go to strike the vein found in No. 1 crosscut. The veins are parallel, 320 feet apart, and can be traced by the surface outcrop about 300 feet.

The veins appear to be diorite dikes inclosed in hard walls of basic diorite, and do not show any quartz. The finely disseminated copper sulphides are scattered rather sparingly through the dike rock and no high grade streaks of ore had been found. One shift was employed in No. 3 crosscut, making about 2 ft. a day.

A new mill building houses a steam boiler and small air compressor which supplies the machine drills. There is a small blacksmith shop and a boarding house. A flotation plant was planned, but none of the equipment for it had arrived at the end of July, 1920. There is a good stand of timber on the claims for mining use. Water is taken from Taylor Lake through 4 miles of ditch and 600 ft. of pipe. For active

operation the lake level would have to be raised 10 ft. Nine men were employed.

Bonanza and Bobtail Claims. S. P. Jacks and G. M. Cooksie, owners. Property comprises 2 unpatented claims in section 20, T. 27 N., R. 11 E., near the Taylorsville-Engels road, 3 miles southwest of Engels and 1 mile from spur on Indian Valley Railroad. It was idle in July, 1920, and was not visited, but the owners stated they had shipped lately part of a car of ore carrying 7% to 8% copper and 40 oz. silver a ton, which was taken from a small high-grade vein near the surface. The Snowstorm mine adjoins on the north.

Calnan Group. Formerly called **Little Joe** and others. Owner, M. J. Calnan, Genesee. Located in sections 11 and 14, T. 25 N., R. 11 E., about two miles from Genesee by road, at an elevation of 4300 ft. There are 8 unpatented claims, called Little Joe, Baltimore, Keystone, Mother Lode, Gold Fish, Evening Star, Home Rule and True Friend, covering about 5000 feet along copper-bearing outcrops.

These are mostly old locations and some prospecting or mining has been done on all of them. The ores are carbonates and sulphides of copper carrying some gold and silver. There are massive quartz veins on some of the claims that have never been prospected. On the Keystone claim a tunnel was driven 210 ft. and 90 ft. below the outcrop on a vein a few inches to one foot wide, carrying malachite. There are 2 old shafts 30 ft. and 80 ft. deep and an open cut 40 ft. by 100 ft. on the Little Joe claim, which has a record of 30 tons production of sorted ore in 1906 that is said to have carried $300 a ton. There are 2 shallow shafts and 240 ft. of drifting on the Baltimore claim, a 30-ft. shaft on the Gold Fish, and a tunnel 160 ft. long on the Mother Lode claim, but no known production except on the Little Joe. W. W. Adams of the American Smelting and Refining Company had an option on the claims for a year, but gave them up. In July, 1920, preparations were being made to promote the property. J. W. Rowell, Claus Spreckels Building, San Francisco, was interested. The Five Bears mine adjoins on the west, and the Gruss mine is 1500 ft. north. There is good pine timber on the claims and enough water flows past the Keystone tunnel for milling, with the possibility of developing some power from a nearby creek. The electric power line to the Walker mine crosses one claim. There is no equipment on the claims.

Copper Group. Under bond in July, 1920, to Thomas Lane, Angels Camp. Eight unpatented claims in sections 11 and 14, T. 25 N., R. 11 E., 4 miles from Genesee, east of the Calnan Group. Elevation about 5000 feet.

There are 2 old tunnels and a winze driven years ago and about 50 feet of later work on a lower tunnel which is said to be several hundred feet below the outcrop. The ore, principally tetrahedrite, carrying gold and silver, occurs in bunches in a quartz vein 4 ft. wide. Idle in July, 1920.

Copper King Group. Sobero Brothers, Genesee, owners. Comprises 8 unpatented claims in sections 12 and 13, T. 25 N., R. 11 E., about 5 miles from Genesee at elevation from 5000 to 5500 feet.

The United States Smelting, Refining and Mining Company bonded the claims recently and found a bunch of 4% copper ore 30 ft. deep, 22 ft. long and 22 ft. wide, according to one of the owners. They sank through this bunch, drove past it, and gave up the bond. Idle in July, 1920.

Engels Mines. Owner, Engels Copper Mining Company, 393 Mills Building, San Francisco, California. The property consisted of 23

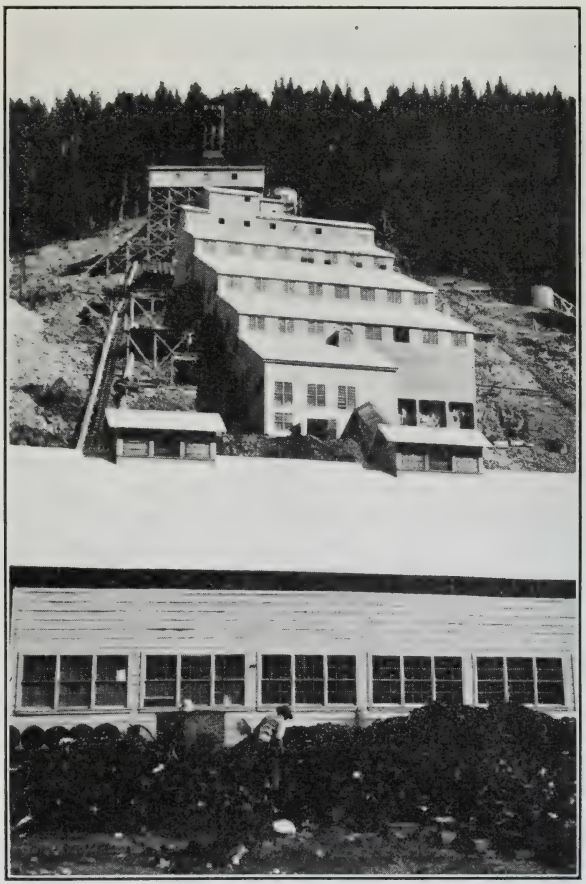

Photo No. 57. Mill of Engels Copper Mining Company, Engels, Plumas County.

patented claims and 131 unpatented claims in July, 1920, a total of about 3050 acres, at and near the northern terminus of the Indian Valley Railroad. Elevation at Engels Shaft is 5263.47 ft.

The geology of the ore deposits at the Engels and Superior Mines has been studied, first by H. W. Turner and A. F. Rogers[1] and later by L. C. Gratton and D. H. McLaughlin[2] and their conclusions are summarized in this Bureau's report on "Mines and Mineral Resources of Plumas County," 1918, so this phase need not be exten-

[1]See Economic Geology, Vol. 9, No. 4, 1914.
[2]See Economic Geology, Vol. 12, No. 1, January, 1917.

sively covered here, especially as there appears to have been no recent evidence found to dispute materially the conclusions in the later of these two papers. The big difference in the ore coming now from the two mines is that the Engels ore is mainly disseminated and relatively low grade, while that from the Superior is more often in stringers and veins of higher grade and more of it is secondary.

In the Superior Mine the open cut was still being worked late in July, 1920. No. 2 level, entered by a tunnel 570 ft. long is 270 ft. deep and was the deepest level worked. The shaft had reached a depth of 80 ft. below No. 2. In the Engels Mine the shaft has reached a depth of 60 ft. below No. 7 level, or 782 feet. Levels No. 1 and 2 are caved; No. 3 is open for 240 ft.; No. 4 is 1240 ft. in length but caved for 160 ft.; No. 5 (above No. 4) is open for 720 ft.; shaft level open for 1280 ft.; No. 6 open for 2360 ft.; and No. 7 had been opened 60 ft.

The Engels ore body strikes N. 60° E., dips 75° N. and rakes NE. 50° and the shoot lengthens with depth. It has a maximum width of 120 ft., average width 60 ft., average length 800 feet and is narrowest in the center. A fault plane striking N. 30° W. and dipping 60° SW. and with vertical throw, traverses the ore body and the section south of the fault is oxidized. The ore is nearly all removed above the fourth level and workings caved. The ore body naturally has no well defined walls.

Stopes are carried 120 ft. long and are cut to rib pillars 20 ft. thick. Levels are far apart, No. 7 being 202 ft. below No. 6, and No. 6 is 240 ft. below the shaft level. Grizzly chutes are used, as the superintendent thinks ore can be handled much more cheaply through them than on shovelling platforms. Above No. 4 level the ore shoot has been stoped 800 ft. long, 60 ft. wide and 180 ft. high, and is being stoped from No. 6.

Ore from Engels Mine is broken in a 24″ x 36″ Allis-Chalmers crusher and hauled by electric trolley 3000 ft. to the ore bin. An aerial tram 9800 ft. long with 56 buckets of 1000 lb. capacity each makes the round trip from Engels Mine to the mill at Superior Mine in 55 minutes, dumping all the ore in a 900-ton circular steel receiving bin at the top of the mill. The mill heads are thought to run not less than 2¼% copper, but vary widely depending on which mine the ore is coming from.

No complete flow sheet of the mill has been prepared but the following indicates the principal steps in ore treatment. Ore from receiving bin goes over a 30″ belt conveyor to a 4-inch grizzley, oversize on grizzley going to a No. 8 Traylor gyratory crusher. Ore over 1¾ inches passes over another grizzley to a belt conveyor and to two No. 5 gyratory crushers, crushing to 2½ inches. Belt conveyor delivers to a trommel, with 1 inch to 2 inch screen; oversize from trommel to 54″ x 20″ Superior rolls; undersize from preceding grizzlies and trommel and product of rolls delivered to four 900-ton circular steel ore bins.

The ore from bins is fed by belt and band conveyors to three 8′ x 36″ Hardinge mills moving 23 r.p.m. and a No. 86 Marcy mill moving 26 r.p.m. Feed in Hardinge mills is 80% solids. Model D classifiers moving 27 strokes per minute classify ball mill product; oversize goes to three tube mills (2 of them 6′ x 12′ and one 7′ x 10′) and an 8′ x 36″ Hardinge mill. The product of these mills is from 100 to 200 mesh

and 50% is finer than 200-mesh. Fines from above classifiers and product of last mills is diluted to 30% solids and fed to 12-cell 24-inch low-level Minerals Separation flotation machine. Product of first 3 cells is taken off as concentrate; product from next 4 cells is sent to a Callow cleaner unit, and product from last 5 cells goes to a Callow rougher and thence to Callow cleaner. Callow cleaner tailing, classified, etc. Concentrate from Callow cleaner is thickened in Dorr thickener, filtered on an Oliver filter and all the concentrate passes down a long belt conveyor to the loading shed at railroad. The oil mixture for flotation consists of 45% fuel oil, 40 to 45% crude turpentine, and 10% gasoline for thinning. Distillate could be used for thinning in place of gasoline if obtainable, but coal oil will not do. Air under 4 lb. pressure is used; less than 1 lb. oil per ton of ore is required. The mill also contains twelve 18-inch high-level Minerals Separation flotation cells.

Concentrate assays .08 oz. gold, 8 to 10 oz. silver per ton and 30% copper. This new mill is presumed to have a maximum capacity of 1500 tons a day but was handling 650 tons a day of ore and producing 210 tons of concentrate a day at time of visit. Shortage of good miners was hampering operations. A total force of from 380 to 400 men was employed.

Five Bears Mine. Five Bears Mining Company, G. H. Goodhue, manager, address, Indian Falls via Paxton, California. Located near the Gruss mine in sections 23, 25 and 26, T. 25 N., R. 11 E., 3 miles southeast of Genesee by road. Contains 9 quartz claims and one placer claim, all being patented except one. The total area is 204 acres, covering 8100 feet along the lode.

The property is described in this Bureau's last report on "Mines and Mineral Resources of Plumas County." Like some other mines nearby, the ore near the surface in the oxidized zone, was valuable principally for its gold and silver content, but in depth becomes a copper sulphide ore, which was yielding about 2.6% copper in the last operations.

The mine was worked through a tunnel 1400 feet long, 900 feet below the outcrop. It was equipped with a mill of ten 800-lb. stamps, 2 Eccleston concentrators, small compressor, etc., all operated by Pelton wheels receiving water from Ward's Creek.

The property has been worked only irregularly in late years, and was idle when visited in July, 1920. Considerable of the equipment had been removed and the buildings were in run-down condition. The Gruss mine, on the north, is on the same lode.

Gruss Mine. Formerly called the **Genesee Mine.** Owner, Gruss Mining Company, address, room 704, 381 Bush street, San Francisco. W. J. Gruss, president and superintendent at the mine. Located in the SW. $\frac{1}{4}$ of NW. $\frac{1}{4}$ of section 14 and SE. $\frac{1}{4}$ of NE. $\frac{1}{4}$ of section 15, T. 25 N., R. 11 E., 3 miles by road from Genesee. Contains 9 unpatented claims, covering two sections of the lode, 2700 ft. and 1500 ft. long, respectively. Elevation 3800 ft. at mill.

The geology of the mine as disclosed in the upper workings is described in this Bureau's last report on "Mines and Mineral Resources of Plumas County" (1918). Since that report the shaft has been sunk

to 400 ft. vertical depth. The lode strikes N. 10° W. and dips 65° W. and has been traced 1300 feet on the surface. There were 3 levels at 70, 200 and 400 ft. when visited by the writer, July 27, 1920. The 200 level had been driven north 275 feet, and south 175 feet, and the 400 level north 245 feet and south 250 feet. The shaft passed into the footwall between 200 and 400 levels. The 200 level north shows a stringer lead of quartz and calcite between a grey slaty schist hanging wall and meta-andesite footwall, with some bornite disseminated through the hard grey wall rock. From No. 1 crosscut on the 200 level south, which is not drifted on the vein, they had exposed the formation 16 ft. wide and had raised 45 ft. on it. On the 400 level south, the drift was not on the vein for 200 ft., but at that distance from the shaft they cut a black slate gouge carrying quartz stringers and had drifted on it 50 feet. On the 400 level north, the footwall is hard, dark green meta-andesite and hanging wall is slaty black schist. There was no

Photo No. 58. Mill building and headframe at Gruss Mine, near Genesee.

gouge north of shaft. The superintendent claimed the "slate" was gold ore, with the gold presumably in the pyrite.

Three men were working underground when visited. The mine gives considerable water, nearly all of it coming in along the shaft. There is a 10″ Cornish pump in the shaft and an 8″ lift pump on the 400 level. The shaft and mill are on the Genesee claim in the SE. ¼ of NE. ¼ of section 15, and so far as known no work was being done on the other claims. On the 400 level a crosscut had been driven 245 ft. east in search of the Cooper vein, and it was though it would require 155 ft. more crosscut to reach it. No pay shoots had been blocked out as far as known, when the property was visited, although Gruss stated they had mined an ore shoot in years past which was 150 ft. long 125 ft. above the 200 level north.

Hoisting is done in a cage. Ore is crushed in a McCully crusher in the headframe and drops into the mill bin. The mill contained 10 light stamps and 2 Eccleston concentrators that had just been brought from the Five Bears mill. A 50-ton Minerals Separation flotation plant

was being prepared for. A force of 9 men were working on the surface. Power is furnished by water from Wards Creek under 145 ft. head, taken through $\frac{3}{4}$ mile of ditch and 2700 ft. of 16″ pipe. There is a small hoist, an 8″ x 8″ Ingersoll Rand air compressor in use, and one 12″ x 12″ not in use.

Lena Group. Sobero Brothers, Genesee, California. Six unpatented lode claims, 7 miles by road and trail from Genesee in sections 6 and 7, T. 24 N., R. 12 E., at an elevation of about 6700 feet, near the summit of range on the west slope.

A quartz vein reported to be 16 ft. to 20 ft. wide striking SE. and dipping east, carrying chalcopyrite, bornite and chalcocite, has been prospected by adits. An upper adit 75 ft. below the outcrop is a crosscut for 210 ft. and then drifted for 50 ft. on the vein. The lower adit is 350 ft. below the outcrop and 360 ft. distant on the strike from the upper adit. It is a crosscut 1200 ft. long, said to be in ore at the face. A winze was sunk 85 ft. deep from the upper drift and a shaft 25 ft. deep from the surface. The ore found was apparently in bunches. The United States Smelting, Refining and Mining Company did most of the work on the claims, but gave up their bond. Since then parties supposed to represent the same company have located claims surrounding the longer adit and were having their claims surveyed in July, 1920. The Walker mine is nearby in sections 5, 6, 31 and 32 on the north.

Pilot Mine. Formerly called the **Borden Mine.** Goodhue Brothers, Genesee. In sections 14 and 15, T. 25 N., R. 11 E., about 3 miles by road from Genesee. The property contains 2 unpatented claims.

The upper portion of the vein was worked years ago by John Borden, who crushed the ore in an arrastra to recover the gold and silver.

The lode strikes N. 10° W., and dips 65° W., and the ore so far worked was from a few inches to 18″ wide, consisting of seams of bornite and grey copper sulphides carrying some gold and silver, in quartz.

There are 2 tunnels on the property, the lower being a crosscut about 600 feet long to vein, and about 360 feet on the dip below the upper one. The shoot was worked from the upper tunnel by Borden. From the lower level there was 20 ft. of drift on the vein and a small stope, this lower working being recent. There have been 2 small shipments of sorted ore from the mine since October, 1918. It was idle at time of visit but was reported to have been bonded, together with the adjoining Cooper group, by Thomas Lane of Angels Camp. The mine lies between the Gruss and Five Bears mine on the same lode.

Reinmiller Group. Reinmiller Copper Mines Company, John Reinmiller, president, Engels, California. The property contains 56 unpatented lode claims, located north of the Engels mine.

To date, comparatively little work has been done on the claims, but as far as prospected, indications are reported very encouraging. Late in September, 1920, a shaft had reached a depth of 65 feet and was reported to be in milling ore, and the vein was said to be traceable east and west on the strike for 400 feet. There is an adit 70 feet on

the vein 140 feet west of the shaft and another short adit farther west. A third adit was planned, which is to be a crosscut 700 ft. south of the shaft and is designed to strike the vein 400 feet below the collar of the shaft on the dip.

Ruby Mine. Formerly called the **Williams and Stark.** Ruby Copper Company, 717 Kohl Building, San Francisco; H. E. Bush, manager; J. L. Williams, superintendent at mine. The property comprises 17 unpatented claims in the Moonlight district, in sections 13 and 24, T. 27 N., R. 10 E., 5 miles from Engels by road and 2 miles by road from a siding on the Indian Valley Railroad, at an elevation of from 4500 to 5500 feet.

The mine was operated 3 years by Williams and Stark and ore to the value of $16,000 was produced and shipped, according to Williams, before the present stock company took hold of the mine in October, 1919.

The ore is principally bornite. A basic dike about 5 ft. wide strikes N. 25° W., and dips 65° E., in hard diorite country rock. The ore as far as developed at time of the writer's visit, July 24, 1920, occurs as stringers of high grade from 1″ to 18″ in width, crossing the dike and following the foot or hanging wall. This dike had been followed for a distance of 300 ft. by an adit driven 200 ft. below the outcrop, and it was claimed that the ore had been traced 500 ft. ahead of the face of drift on the surface, so the adit was being extended. The gangue of the ore is the broken dike rock and a subordinate amount of quartz. One stope 35 ft. long and 75 ft. high has been worked above the level. The ore is stated to run as high as 30% copper at times, with usually one ounce of silver for each per cent of copper.

When visited, a gravity tram 1600 ft. long was being built to send the ore from the mine to the mill, and was expected to be finished by August 15. A mill of five 1000-lb. stamps, one Wilfley concentrator and a vanner, was being put up. The operators hoped to crush from 20 to 25 tons of ore a day, but it is doubtful if they can handle over 15 tons a day, as the ore is very hard. There is a chance to handle some of the ore by coarse crushing and jigging. The mine is equipped with machine drills, a 11″ x 12″ Rix air compressor run by a 50-h.p., 440-volt motor, and there are a small blacksmith shop and several camp buildings. Fourteen men were employed. Water is available from Moonlight Creek. There is ample good pine timber on the claims. Electric power is supplied at the property by the Great Western Power Company. The Trask and Coffer mine adjoins on the south.

Snowstorm Mine. Feather River Copper Company; Geo. W. Long, president; H. E. Bush, manager; home office, 15 Central Building, Phoenix, Arizona; mine address, Engels, California. The property consists of 22 unpatented lode claims, containing about 450 acres, surrounding the corner common to sections 17, 18, 19 and 20, T. 27 N., R. 11 E., a little over a mile south of Engelsby road and ½ mile by road from a siding on the Indian Valley Railroad. Elevation 4580 ft. at tunnel portal.

This company at time of visit had not found an ore body. They were basing their work and their expectations entirely on the fact that their tunnel is only 1000 feet southeast of Engels Superior No. 2 claim,

and that it is being driven in rock of the same character as that carrying the Superior ore body.

Late in July, 1920, their crosscut was 1200 ft. long and it was planned to continue to a length of 2000 ft., where the depth below the surface will be 1000 feet. The work up to that time was in hard granodiorite. The property is equipped with a Sullivan air compressor, 307 cu. ft. free air capacity, a 9-inch suction blower for ventilation, and machine drills. Electric power is supplied by Great Western Power Company. There is good pine timber on the claims.

Trask and Coffer Mine. Formerly in part known as the **Beetle Mine**. Trask and Coffer Mining Company, E. C. Trask, President, and C. L. Eaton, manager, Engels, California; E. R. Solinsky, secretary, Call Building, San Francisco. The property contains 16 unpatented mining claims, with an area of about 300 acres, covering 4000 feet along outcrop. It is in sections 24 and 25, T. 27 N., R. 10 E., and in sections 19 and 30, T. 27 N., R. 11 E., in the Moonlight district, 3 miles by road from siding on Indian Valley Railroad, at an elevation of 4225 feet.

The Beetle claim was worked as early as 1874, and some ore was smelted at Genesee. It was relocated in 1906, but the present company and their immediate predecessors have been working it for the past four years.

The country rock immediately surrounding the present workings is basic igneous, probably diorite and andesite principally, although there are some indications of ore in a flinty chert south of the mill. The vein, which has a maximum width of 2 feet, but averages 4″ to 6″ wide, follows a fine-ground basic dike in places 8 ft. wide. The vein consists of quartz, calcite and dike rock, carrying tetrahedrite, bornite and chalcopyrite, and considerable silver, as well as $2 to $3 gold per ton. The vein strikes N. 20° W. to north and dips east at a very steep angle. It follows the footwall usually, but crosses the dike in several places to the hanging wall.

The vein has been followed by a tunnel. This is a crosscut for 175 feet and a drift on the vein for 800 feet, reaching a depth of 200 ft. below the outcrop. There is a fault dipping 45° south that crosses the vein on the south about 50 ft. from point where crosscut strikes vein. There has been no work south of fault on this level. Two winzes have been sunk on vein in the floor of the drift. They are 400 feet apart, and 70 ft. deep and 30 ft. deep respectively. In the block of ground below the level and between the winzes there has been about 50 ft. in length stoped. This ground was partly under water at time of visit but Trask stated there is 8 inches of solid ore in the face that assays 15% copper and 60 oz. silver per ton. He said 160 tons of ore have been shipped that yielded an average of 10% copper, 40 oz. silver and $3 gold a ton. Above the level there are some old stopes and chutes and work has broken through to the surface. The vein at the face of level is very narrow, but they claim that 300 ft. ahead of the face they have an outcrop 50 ft. wide carrying disseminated bornite and can trace a copper-bearing outcrop 6 ft. wide for 3000 ft. farther on the strike, so the vein evidently persists. There is also an east-striking outcrop south of the fault, which carries some copper near the surface, but is unprospected so far.

The mine is equipped with a 12″ x 14″ Chicago Pneumatic Tool Company air compressor, run by a 40-h.p., 50-amp., 440-volt motor, and machine drills are used.

The mill contains 5 Union Iron Works 1000-lb. stamps, and a Frue vanner, and is operated by a 35-h.p., 50-ampere, 440-volt motor. There is also a gas engine. Electric power is furnished by Great Western Power Company. There are several new camp buildings on the property.

The richest ore is the tetrahedrite, which is sorted and shipped. Concentration tests gave a product carrying 10% iron, 16% copper, 64 oz. silver and $3 to $4 gold a ton. Little milling has been done.

There is ample good timber on the claims and enough water for milling and camp uses. The Ruby mine adjoins on the north. Property was idle when visited July 24, 1920.

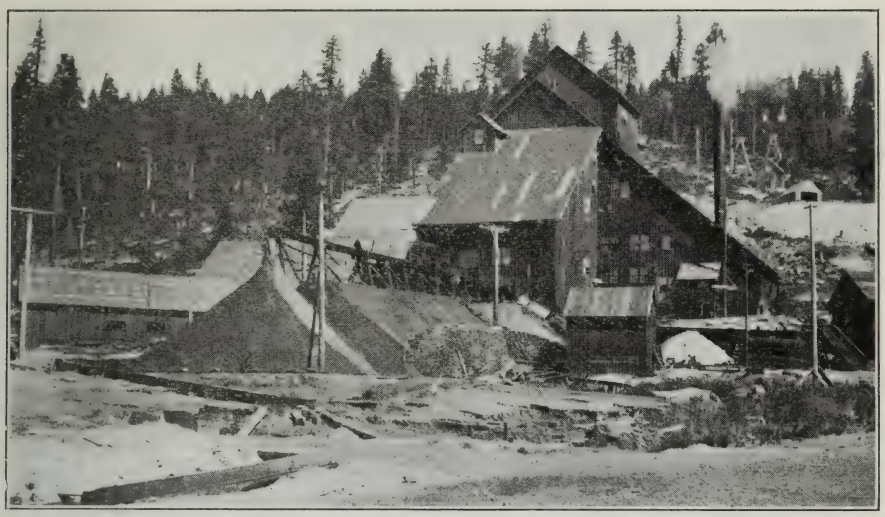

Photo No. 59. Flotation Plant, Walker Copper Mine, Plumas County.

Walker Mine. Controlling interest owned by International Smelting and Refining Company, a subsidiary of Anaconda Copper Mining Company; main office, 618 Kearns Building, Salt Lake City, Utah; mine address, Portola, California; V. A. Hart, manager; J. S. Hazen, superintendent. The property comprises 53 lode claims, about 1060 acres, partly patented, covering 13,500 ft. along the strike, and is in sections 5 and 6, T. 24 N., R. 12 E., and sections 31 and 32, T. 25 N., R. 12 E., 21 miles by road from Portola, a station on the Western Pacific Railway, or 8 miles by steep mountain trail from Genesee, in Plumas National Forest. The upper camp is at an elevation of 7004 ft. and lower camp and mill are 4800 ft. distant and 800 ft. lower.

The present company began work in 1916, previous to which little was done. They prospected the property over two years before buying control of it. The flotation plant of 85 tons capacity was put up in October, 1916, and was enlarged in 1918 to 160 tons daily capacity. Concentrate up to this season has been hauled to Portola by auto

trucks. The plant was in full operation when the writer visited the property in July, 1920, but in November, 1920, operations were greatly reduced.

Eruptive rocks cover the surface immediately above the workings, but the condition of the vein on the south end of No. 3 level (210 ft. deep vertically) suggests it is near the old surface, as the sulphides are leached and oxidized. The vein is a strong, well-defined quartz filled fissure in hard diorite walls. It averages 20 ft. wide on No. 3 level and 45 ft. wide on No. 4 level. There is no gouge on either wall. The vein strikes S. 30° E., and dips 70° E., and has been proven so far for 2400 ft. on the strike.

Five levels, numbered 1, 2, 3, 4 and 8, have been opened in the mine. The first four levels comprise the present upper workings, which are worked through the vertical and inclined shafts, with exit at very nearly 7000 ft. elevation, and which at present are not connected underground with No. 8 level. There is a crosscut 1360 ft. long from surface to vein at No. 2 level (125 ft. deep). No. 3 level is reached by a vertical shaft 210 ft. deep, and No. 4 level is 150 ft. below No. 3 on the dip of vein and is reached by an inclined shaft. No. 8 level, elevation 6200 ft., is a crosscut adit for 3661 feet and had been drifted on vein for 1100 feet at time of visit (July 22, 1920), and was being advanced at the rate of 4 ft. a day.

The present shoot is said to be worked out above No. 2 level. No. 3 level is a drift on the vein for 1200 ft. north of inclined shaft. On the south end, as noted above, the sulphides in the vein have been leached and oxidized and the metal content is too low to make ore. The ore shoot on this level was opened for 900 ft., running 580 ft. south and 320 ft. north of vertical shaft. The stope was up 45 ft. above the level, on ore 20 ft. in average width, with a streak of higher grade 5 ft. to 6 ft. wide on the hanging wall for several hundred feet on the north end. A fault on this level threw the vein about 6 ft. Going north on this level beyond the leached ground the ore contains from 1½ to 10% copper, averaging probably 3½% copper and .1 oz. gold, .6 oz. silver per ton. No. 4 level is drifted 1200 ft. south of the inclined shaft. There is a fault 200 ft. north of the face and vein on south of the fault was lower grade, containing only 1% copper at the face. The fault relations on this level were obscure and had not been solved yet. From the fault north for 300 ft. the ore was of good milling grade, then for 140 ft. a high-grade streak came in 5 ft. to 6 ft. wide and assaying 15% to 17% copper. In the stope being started on this level the vein was 45 ft. wide and was said to be all ore. Diamond drilling on this level struck a heavy flow of water, which was shut off with difficulty.

Chalcopyrite is the most prominent copper mineral in the ore, but it carries considerable bornite and in the richest streaks pyrite is plentiful. The writer noticed some barite in the vein on the 3rd and 4th level, but it is not plentiful.

On No. 8 level, which will be the main working entry when connection is made with the upper levels, the vein was struck 3650 ft. from the portal. About 1000 ft. from portal was in heavy and running ground, where considerable water was struck. The first ore shoot was drifted on for 300 ft., then a stock of granite or granodiorite 30 ft. wide was encountered, and the rock for 250 ft. beyond it was low grade. They then came into the second shoot, and it had so far been drifted on

for 800 ft. and was said to show 4% copper in the face. No crosscutting had been done on the vein on this level in July. A fault on this level throws the ore a few feet east, looking north. These faults appear to be associated with the later intrusions of granodiorite. A raise from No. 8 to No. 4 was up 165 ft. When this is finished all the ore will be brought through No. 8 tunnel, and the upper works, and tramway connecting the two camps, will not be needed.

Mining is done by the shrinkage system, raises being put up every 15 ft. for chutes, which open into the big stope, which was 900 ft. long on No. 3 level. Shovelling platforms were in use. Nearly all the work of breaking ore in the mine was being done on contract at a big saving to the company.

Electric power is supplied by Great Western Power Company over a line 14 miles long from Viramont and the mine is also equipped with steam power for hoisting. The upper works are equipped with 100-h.p. motor, 2 air compressors of 750 cu. ft. capacity each, steam engine and hoist and Krogh Centrifugal pumps on No. 3 and No. 4 levels. There is a compressor and blower at No. 8 level. Denver Dreadnaught and Ingersoll water drills are used entirely.

Ore is brought from the upper workings by a tram 4800 ft. long carrying 16 buckets. It is dumped on a 6 inch grizzley; crushed in 20″ x 10″ Blake type crusher and 16″ x 41″ rolls and elevated to mill bin. The feed to the 2 Marcy 100-ton mills is about 1½ inch. These mills travel 26 r.p.m. and require from fifteen to thirty 20-pound balls each a day. Dorr classifiers return the oversize for regrinding and the fines are elevated to three Callow primary cells, using 4½ lb. air pressure. One-half the product from these cells goes to settling cones and the balance to 3 Callow cleaner cells. The tailing from the 3 primary cells goes to 6 Callow secondary cells and the product from secondaries goes to the 3 cleaner cells and thence to the settling cones. Tailings from secondary and cleaner cells are impounded. Concentrate from the settling cones goes to a 5′ x 8′ Oliver filter; overflow to Dorr thickener from which thickened product goes to filter and finally by belt conveyor to outside storage for shipment. The feed to the flotation cells is 60% finer than 200 mesh.

For flotation, 4 lb. coal tar and 2 lb. Yaryan pine oil per ton of ore are used. The pine oil runs freely, but the coal tar has to be heated by steam coils to reduce its viscosity, even in summer. The ratio of concentration is 5.7 to 1. The concentrate assays 18% to 20% copper, 7 oz. silver and $4 gold a ton. A recovery of 94% of the copper and 73% to 75% of the gold and silver in the ore is claimed. The present capacity is about 160 tons a day.

SIERRA COUNTY.

There has been about the usual amount of prospecting in the county during the past year, but most of this work has been on mines previously described in this Bureau's reports. Below are listed most of the properties that have been active during the year. Generally speaking, the county's quartz mines are in the development stage. While there are some of them, like the Tightner and Plumbago, that have produced considerable phenomenally rich ore, from pockets, development has nowhere reached a depth of over a few hundred feet.

QUARTZ MINES.

Belmont Mine. Near Alleghany. Two adits have been driven to develop a vein about a foot wide, and Peter Flowers and L. C. Harden, who have been working on the property, planned to put up a small mill last summer.

Bessler Mine. L. and T. Bessler, Downieville. It is at the north boundary of the town of Downieville, on the edge of the serpentine belt that has produced numerous rich pockets, some of which have come from this property. Late in October, 1920, the Bessler Brothers planned to put up a 5-stamp mill, and some ore had already been mined for crushing. The mine is on a steep mountain side, and is developed by adits, with about 150 feet of backs.

Comet Mine. Gold Exploration Company, F. O. Richardson, manager. Located in Jim Crow Cañon, southeast of Downieville. A wide vein carrying free gold and arsenopyrite, has been prospected during the past summer by two adits, 130 feet apart, the lower one of which is about 200 feet below the outcrop. Late in the summer, it was reported the upper tunnel had been drifted on ore for 175 feet.

Cleveland Mine. In Sierra City district, about 3 miles by road southwest of Loganville. This property has been operated by R. G. Gillespie of Pittsburg, Pennsylvania, since 1915. There is a 10-stamp mill and considerable mine equipment, all electrically operated. Gillespie stated late in 1919 that he had made no discoveries of particular interest or importance, although the shaft has been sunk several hundred feet and the mill has been operated. It was reported in September, 1920, that the mine was to be closed.

City of Six Mine. A. E. Hodgkinson, et al. Property is about a mile and a half south of Downieville.

The vein is developed by 2 adits, about 300 feet apart; the upper one is 700 feet long with raises and winzes on the vein, and the other is about 1150 feet long, but not yet in ore. Some work is done every summer on the property.

El Dorado Mine. This mine is in the cañon of Kanaka Creek, adjoining the Tightner mine, about ½ mile from Alleghany. Sinking was in progress last summer to open, if possible, at greater depth the three small, rich shoots previously worked. Ten-stamp mill operated part time.

Kanaka Mine. Ambrose Madden, owner. Located near Alleghany. The adit was advanced during the past season.

Kate Hardy Mine. On Oregon Creek, 2 miles southwest of Forest City. Described at length in our last report.

New equipment was put in the past spring, and a winze is being sunk from the lowest tunnel to explore a prospect found in the tunnel. It was planned to open a level 100 ft. below the tunnel and to continue sinking to 200 feet.

Mariposa Mine. It is in the cañon of Kanaka Creek about a mile from Alleghany. An inclined winze was being put down on the vein during the past summer, from the longest of 3 adit drifts, which were driven years ago and produced high grade. There is a 5-stamp mill (old), an electric hoist and compressed air equipment on the property.

Monarch Mine. Located 3 miles northwest of Sierra City. Mine and 20-stamp mill have been in operation several years, under bond held by R. G. Gillespie, Pittsburg, Pennsylvania. During the past summer drifts were being driven on the 300 level to develop ore found early in the spring. The property is well equipped, having a hydro-electric plant, pole line, sawmill and double drum hoist.

Oro Mine. John Rosenfeld's Sons, San Francisco, owners. Reynolds, Stevens, and Mastick of San Francisco and John Costa, Downieville, lessees. Mine is $\frac{1}{2}$ mile from Downieville by trail.

The vein is a stringer lead of quartz between a slate footwall and slate, accompanied by a basic dike, on hanging wall. Vein has a maximum width of 5 ft., average width 1 ft. The pay so far has occurred in small bunches with a strip about 4 inches wide on hangingwall quite rich at times. The vein is developed by five adits, the lowest of which is possibly 500 ft. below the outcrop. No. 4, the lowest adit, was a drift 800 ft. long with a branch drift 375 ft. long when visited. A winze had been sunk 15 ft. below the level. There is a water blast for ventilation in the drift, operated by water from an old upper adit.

Sixteen to One Mine. This mine is $\frac{3}{4}$ mile southwest of Alleghany on side of cañon of Kanaka Creek. In the recent lawsuit between this company and the Twenty One Mining Company, the Sixteen to One was given judgment for $60,000 for ore extracted from its property. The Sixteen to One has purchased the Twenty One property and has been running its own mill.

Tightner Mine. The property is just south of Alleghany on the north side of cañon of Kanaka Creek, some of the workings extending under Alleghany.

Work was resumed in the mine early in 1920 under an agreement that a stated amount of money was to be spent in development work; the stockholders agreed to set a stated value on their stock, and if the development satisfies the prospective buyers they are to take up the stock, the current report being that the price would be $400,000.

DRIFT MINES.

Drift mining generally through the Sierras has been almost at a standstill during the past two seasons because of the lack of snow and rain, unfavorable financial conditions, and scarcity and cost of labor. Sierra county has been known particularly for its drift mines for many years. A resume of drift mining operations in the county for the year 1920 can be little more than a list of the properties on which some work has been done, as only a very few of them have made any production.

Arizona Mine. Located in Jim Crow Cañon southeast of Downieville. Hugh McCormack cleaned out part of the old 1800 ft. tunnel and started two upraises early in 1920. He is said to have found good gravel in both these, and a heavy flow of water.

Brown Bear Mine. Owners, H. Tibbey et al., Downieville; lessees, Wilcox and Smith, Downieville, known as Brown Bear Mining Company. The mine is 5 miles by trail north of Goodyears Bar at an elevation of 5100 ft. on the east side of St. Charles Hill in sections 13 and 24, T. 20 N., R. 9 E., and sections 18 and 19, T. 20 N., R. 10 E., containing 260 acres and covering 3 miles along supposed course of channel.

The channel was being sought through an adit 430 ft. long, N. 30° W., leading to an incline 300 ft. long, from the foot of which a tunnel had been driven 480 ft. at time of visit. A raise put up 84 ft. from a point 402 ft. from portal of adit was in pipe clay and a raise 28 feet high from near face of lower tunnel showed gravel with bedrock pitching west, indicating they were on east rim.

The property is equipped with a horizontal steam boiler, 12-h.p.; a vertical steam boiler of 20 to 25-h.p., a 3″ Worthington pump and other pumps, a hoist, saw, etc. The boilers require about 4 cords of wood in 24 hours, necessitating several men for woodchopping.

Assuming a grade of 100 ft. per mile in the channel between this property and the Wehe mine, 2½ miles distant and apparently on same channel, the work should have bottomed channel. That it had not, may be due to channel having a flatter grade than supposed or to it being faulted down between the two mines.

Gibraltar Mine. Gibraltar Consolidated Gold Mining Company, Downieville. The mine is in Poker Flat mining district, 9 miles east of Table Rock.

There is an old adit 1780 ft. long, from which a shaft was sunk 310 ft. deep, from a point 400 ft. in adit. A new tunnel, intended to strike the channel about 400 feet south of shaft, and which was expected to be driven about 1000 ft. before reaching the gravel, has been driven about two-thirds of the distance.

Hilda Mine. Under lease and bond to Hilda Gold Mining Company. This old property, consisting of placer claims, water rights, etc., lies 2 miles in an air line southeast of Sierra City and 62 miles by road from Nevada City. It was being reopened early in the year. It lies at an elevation of 6000 to 6500 feet. Last operation previous to present company was by Holley of Sierra City. It was formerly hydraulicked

but the present company planned to mine by drifting. There were two adits, 500 ft. and 80 ft. long, respectively, when they began work.

Hilo Mine. Located 5 miles north of Downieville. Bernhardt Brothers annually mine and wash 1000 to 1500 cars of dirt, part of it pay gravel, from this claim.

Kirkpatrick Mine. John C. Donnelly, manager. Located 2 miles north of Forest City. A gravel mill was installed at this property about a year ago and has been operated part of the time.

Monte Carlo Mine. In the NE. ¼ of section 26, T. 21 N., R. 10 E., about 9 miles by trail north of Downieville, on Clark Cañon, a small branch of Rattlesnake Creek.

An adit was being driven the past summer by two men, and indications were that gravel would be found early in September.

Mount Alta Mine. Mrs. R. St. Clair, owner; A. T. Hathaway, lessee. Adjoins the Pleasant View mine on south. Has been worked irregularly for several years; some work has been done in 1920. There is a 4000-ft. adit. Some gravel was mined last year, but water was scarce for washing. In March, 1921, it was reported that gravel running $3 a ton had been struck in some new ground.

Nugget Nell Mine. Located on the headwaters of Goodyears Creek, in section 4, T. 20 N., R. 10 E. Some drilling was being done the past summer to locate the channel in this property.

Poor Boy-Bella Union Mines. Located 4 miles by road and trail south of Port Wine in section 32, T. 20 N., R. 9 E. Fred M. Phelps has had a bond on this group for five years and has been prospecting with a Keystone drill. Late in the fall of 1920 it was planned to begin a bedrock tunnel, which it was estimated would have to be driven about 3000 feet to strike the channel.

Sunshine Mine. D. Sullivan, et al., Downieville. It is near Gold Point on the South Fork of North Fork of Yuba River. Water power was brought to the mine the past summer to run pumps for unwatering the incline.

Table Rock Mine. Table Rock Mining Company, Union Savings Bank Building, Oakland. J. H. Hartley, manager. The mine is at Howland Flat. This company has been working for six years or more. They have been taking out pay during the past year through a tunnel over 3000 ft. long. The gold is coarse, but occurs in a sticky clay, making its recovery difficult. The company has spent probably in excess of $100,000 on the property.

Wehe Mine (St. Charles Hill Mine). F. Wehe, Monadnock Building, San Francisco. The mine is on St. Charles Hill in sections 24, 25 and 26, T. 20 N., R. 9 E., 7 miles by trail from Goodyears Bar at an elevation of 4750 feet. Covers 320 acres, and about two miles of supposed course of ancient channel. Portions of this channel were worked years ago, but channel was said to be faulted down 38 feet in the old works and was abandoned after paying up to the fault. This fault was said to be 700 ft. downstream from the present tunnel. A lower tunnel

was driven 820 ft. at time of visit, a raise had been put up 35 ft. and an upper tunnel from top of raise had been run 130 ft. and has since been advanced farther. Raises from the lower tunnel and bore holes from the upper one are claimed to have struck gravel. The channel is supposed to be wet and hard to handle until drained, so it is planned to extend the upper tunnel for drainage.

HYDRAULIC MINES.

Depot Hill Mine. Joubert Company, F. J. Joubert, Camptonville. This hydraulic mine has been worked with profit on a small scale for many years by the Joubert family.

Marysville and Nevada Water and Power Company. This company has built a concrete dam across the North Fork of Yuba River near Bullards Bar and has received a permit to hydraulic the Brandy City mine, north of Camptonville. This mine is described in our last report.

New Council Hill Mine. H. L. Berkey, manager. Located at Scales, on Rock Creek. This property will probably be operated the present season.

TUOLUMNE COUNTY.

The principal developed mineral resources of the county are the gold quartz mines of the Mother Lode and the East Belt, the deep gravel mines and the marble quarries of the Columbia district. Limestone and lime are produced in important amounts and chromite, copper, platinum, and by-product silver (from gold ores) have been produced in small quantities in recent years. Years ago graphite was mined, and there are undeveloped prospects of many of the industrial minerals and building stones.

Activity during the past year has been confined to mining and milling at a few properties on the Mother Lode, the development of some of the East Belt mines and the operation of the marble quarries near Tuolumne. Time did not permit the writer to visit all the active properties this season, but in some cases where visits were made late in 1919 and where there have been no great changes reported, notes taken then are included.

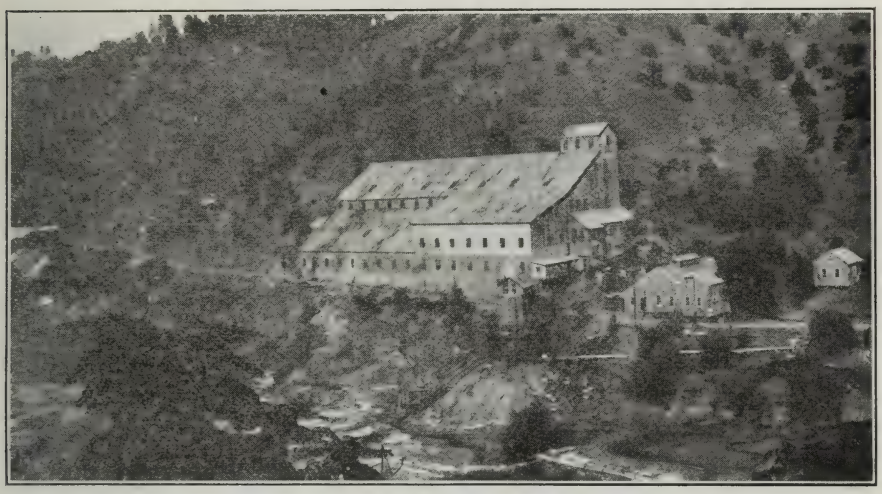

Photo No. 60. Mill at Belmont Shawmut Mine, on the Mother Lode, near Jacksonville, Tuolumne County

GOLD QUARTZ MINES.

Belmont Shawmut Mine. Belmont Shawmut Mining Company, 917 Hobart Building, San Francisco. This company is subsidiary to the Tonopah Belmont Development Company. Mine and mill are on Woods Creek, about four miles from Chinese Camp and two miles from Jacksonville, near the highway to Yosemite Valley.

This property is the largest in point of ore reserves and equipment in the county, and at the same time is so situated that it might be operated even under present conditions at a profit. An excellent article on the mine and mill, describing the property and plant and giving details of mining and milling operations, has been published recently,[1] and need not be repeated here. The property comprises about 2000 acres.

[1] Arthur B. Parsons. The Mine and Mill of the Belmont Shawmut Mining Company. Mining and Scientific Press, October 30 and November 6, 1920.

The ore occurs in a broad fracture zone, filled with quartz stringers and dolomite, on the hanging wall of a basic dike and is invariably accompanied by the bull quartz outcrop. O. McCreaney, superintendent, distinguishes four kinds of ore, namely, banded quartz, impregnated schist, dark and light sulphide ores. The hanging wall is a metamorphic complex of Mariposa formation largely schist, slate and limestone, and the footwall is talc of the Calaveras formation. The intrusive under the vein is a coarse crystalline aggregate composed largely of basic feldspars. The vein strikes N. 32° W. and dips NE. 70°. On the footwall side there is a gouge which swells badly. Between 1100 and 1400 feet the ore and gouge are in contact, but below are separated. The gangue in the deepest levels is mostly dolomite which was first found on the 17th level. The principal pay ore in depth is the dolomite-sulphide ore, which occurs in well defined overlapping lenses 8 ft. to 30 ft. wide. The vein rolls and the ore is on the crests of the anticlines. The ore averages 7% sulphides, the dolomite-sulphide ore containing even more; the sulphide is principally pyrite.

There are three inclined shafts on the property which are 420, 2163 and 720 ft. deep respectively. The present working entry is a crosscut adit connecting with the 2163 ft. shaft 400 ft. below the outcrop, the shaft being caved above that point. The shaft is on the vein to between the 11th and 12th levels then on an angle of 62° to the 18th level, where it is about 80 ft. from the vein in the hanging wall. A winze is sunk 200 ft. deeper, giving a total inclined depth of 2363 ft. Levels open late in 1919 were the adit and 2, 11, 13, 14, 16, 17, 18 and 19. At that time there had been about 30,500 ft. of drifts, 10,000 ft. of raises and winzes and 4120 ft. of crosscuts driven in the mine. Stopes are carried not over 200 ft. long, 10 to 30 ft. wide and 100 ft. high.

The mine was closed August 1, 1920, and the mill two weeks later. Since then the company has employed about 20 men, as compared with a usual working crew of 180 to 190 men. When visited in October, 1920, the superintendent stated they were in position to resume work at any time, as the water was being kept down. The chief reasons given for the temporary closing were the scarcity and inefficiency of underground labor, the electric power situation and high costs.

The mill has a capacity of 450 tons a day but has recently been treating only 300 tons a day. There are twenty 1250-lb. and fifty 1050-lb. stamps crushing to 10 mesh; 8 Butchart tables and 9 Jones Belmont flotation cells. The tables make a sand concentrate which is dewatered in three 28 x 7 ft. dewatering tanks and is worth about $60 a ton. The table tailings are classified in a Dorr Duplex classifier; sands are reground and slimes thickened in 2 Dorr thickeners, passing thence to another classifier, from which the overflow goes to the flotation cells. The flotation concentrate is run over one of the Butchart tables, and is low grade.

Previous to 1920, the present company shipped the concentrate to a smelter. The comparatively low grade of the product, the cost of shipment, and the smelter costs, penalties and requirements became so exacting that they cast about for means of recovering the bullion

on the property. An experimental plant was in use in October for cyaniding old chlorination tailings and some flotation concentrate. They have evolved a method of cyaniding a mixture of roasted table concentrate and raw flotation concentrate, which appears to have solved the problem.

The statement was made by the writer in an article published last year that this company had ore blocked out ready to mine for a long time and did not need to carry on current exploration and development. O. McCreaney, superintendent, takes exception to this statement.

Clio Mine. Clio Vindicator Mines, Incorporated; main office 244 Plymouth Building, Minneapolis, Minnesota; superintendent, Geo. L. Holmes; mine address, Chinese Camp, California. Mine is on Tuolumne River ½ mile below Jacksonville and covers the lode for nearly 3000 feet on the north side of the cañon at an elevation of from 900 to 1450 feet. There are 2 patented claims named Clio and Kershaw, which are 150 ft. wide and 3 unpatented claims and a mill site.

This mine was first equipped with a 10-stamp mill in 1862 or 1863 and was worked five or six years, with recurring periods of activity ever since. It had been idle most of the time since 1912 until the present company began work in November, 1919. The mill has been in operation since April, 1920.

The vein has a swelling serpentine footwall with a heavy gouge and a schist hanging wall. It is a stringer lead with the schist heavily charged with pyrite for an average width of 8 ft. on the 218 ft. level. The vein strikes NW. and dips 69° E.

There are five levels in the mine. The working adit or 218 level is a crosscut driven north from the West Clio about 330 feet to the Clio claim then northwest about 80 feet, where it connects with a shaft giving access to lower levels situated at inclined depths of 306, 361, 473 and 565 ft. Drifts are north of the shaft. The old 218 north drift was about 320 ft. long but was caved over half way and a new drift was driven about 200 ft. long in the footwall, from which a crosscut through the gouge connects with the north end of the old drift. Some small stopes have been started on this end. There is also 130 ft. of drifting on the 473 level and about 350 ft. of work, mostly drifting, on the 565 level. Very little has been done on the 306 and 361 ft. levels. About 25 feet above the 218 adit, and 640 ft. northwest of it, the Heath tunnel, driven east 470 ft. connects with the shaft.

The mill contains 10 stamps, a 10″ x 12″ Blake crusher, and 4 Frue vanners, all operated by a 50-h.p. motor. There is a Leyner compressor, 5 drill capacity, with 75-h.p. motor; and a single drum hoist on the 218 level. Electric power is bought from Pacific Gas and Electric Company. Nineteen men were employed.

The mill was being operated on schist ore from the 218 level in October, 1920. This material is heavily impregnated with pyrite. The vein was pretty well stoped from the old works on the 218 level to surface.

Confidence Mine. Confidence Gold Mining Company, 604 Mission street, San Francisco. The mine is in west half of section 10, T. 2 N., R. 16 E., at Confidence, 14½ miles from Sonora by good road and contains 4 claims.

This is one of the East Belt mines that had a romantic early history and a reported production of five to seven millions of dollars.

The vein is very irregular, ranging from 1 ft. to 15 ft. in width, striking N. 14° W. and dipping 18° to 30° E. between hard granodiorite walls. It accompanies a dike. The gold occurs partly free but largely in rich sulphides, the galena formerly found having run as high as $2 a pound at times.

There are two shafts on the property about 1200 ft. apart, the deepest of which was down to 1210 ft. on the dip or about 540 ft. vertically when property was last visited, the present company having sunk the north or "new" shaft 400 ft. below the old 810 ft. level.

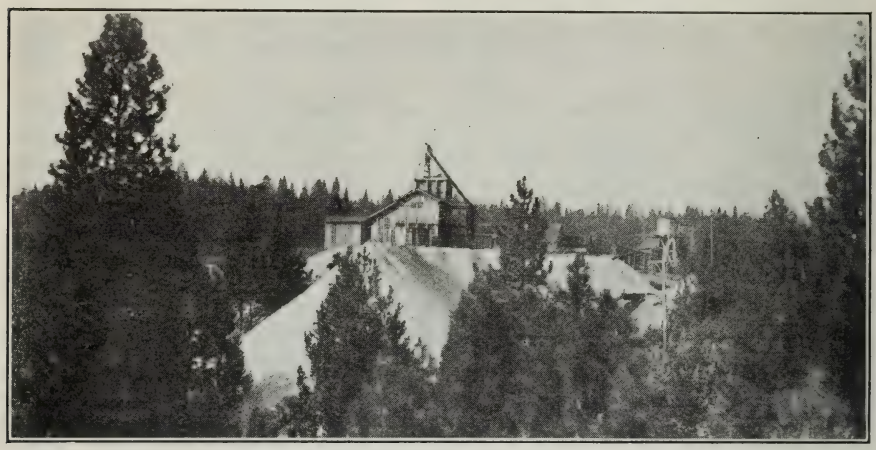

Photo No. 61. The Confidence Mine at Confidence, Tuolumne County.

The original shaft is caved for probably 130 ft. below the collar. There were five levels in the old works and vein was stoped from the 810 level to surface between the shafts. The present company has driven several hundred feet each way on the 900, 1000 and 1100 ft. levels.

Under former operators the problem of ore treatment was never solved, it is said, and the present company is supposed to have met with difficulty of the same kind. The plant which they have erected has been idle a large part of the time. It contains a Marcy mill, capacity 150 tons a day, operated by 75 h.p. motor; Dorr classifier, 2 Senn Panning Motion concentrators, 2 Dorr thickeners, 2 Wilfley concentrators and cyanide treatment plant. The mine is equipped with a Sullivan air compressor 8¾ x 10 in.; a Leyner drill sharpener, and hoist operated by a 22-h.p. motor. Work with a small crew underground has been going on during the past three years.

Dutch-App Group. Under bond to Pacific Coast Gold Mines Corporation, 614 Crocker Building, San Francisco; W. J. Loring, presi-

dent. The property is on Quartz Mountain 2 miles south of Jamestown, and comprises the App, Heslep, Hitchcock, Dutch and Sweeney mining claims and mill sites, 110 acres, with a length of about ½ mile on the Mother Lode.

The present company, which quit work in April, 1920, has been working through the Dutch shaft since November, 1915. They sank this shaft from 1800 ft. to 2350 ft. inclined depth (2070 ft. vertical) and did about 17,000 feet of new development and exploration on the 1350, 1500, 1650, 2050 and 2300 levels on the App and Heslep veins. The 1500 was the main working level, and was extended 1800 ft. Ore was mined and milled from the 1500, 2050 and 2300 levels.

Veins are as follows: West, Footwall (in App), Heslep (hanging wall), Middle vein, and Knox and Boyle. The Footwall vein averaging 10 ft. wide, which was being stoped on the 1500 level, has the bull quartz as hanging wall; the Heslep vein, 15 to 20 ft. wide, is on the hanging wall side of the bull quartz. The Middle vein comes within 5 to 10 ft. of the Heslep vein above the 1500 level, and they were mined as a whole, 30 to 40 ft. wide. The veins strike N. 35° to 45° W.; dip about 65° NE. and the ore is sometimes solid quartz but usually a stringer lead between a footwall of grey schist and hanging wall of black schist. The ore is 8% to 10% sulphide, mostly pyrite, and concentrate is worth about $40 a ton.

The ore treatment was as follows when the mill was visited when in operation late in 1919: Ore from shaft bins was broken to 3 inch size in gyratory crusher under the bins, and conveyed to mill bins from which it was fed to 2 Hardinge mills, grinding to 80 mesh. Pulp passed over plates to amalgamate any coarse free gold; classified, fines elevated and sent over 2 sets of 3 plates each for further amalgamation of gold, then sent to a 16-cell Minerals Separation flotation machine. Flotation concentrate from first 8 cells was cleaned on 2 Wilfley tables, and from last 8 cells was returned to first 8 cells. Flotation tailing was sent to a K. and K. flotation machine, from which the concentrate went to a Dorr thickener, diaphragm pump and Oliver filter and was mixed with the concentrate from Wilfley tables for shipment. For flotation, a mixture of pine oil, water-gas tar, stove oil and beechwood creosote was used. A recovery of 90% to 92% was claimed. The mill was handling 150 tons a day, but had a capacity of 300 tons.

The mines in this group operated for years previous to the war at a profit, on low grade ore, and could no doubt be made to pay again if prices should recede or if relief should be given the industry by proper legislation such as is contemplated in the McFadden bill.

Grizzly Mine. Grizzly Mining Company, Oakland; Otto F. Heizer, superintendent. The group includes the Eureka, Dead Horse, Lady Washington, Grizzly, New Albany and nine other claims 2 miles from Tuolumne in the steep cañon of the North Fork of Tuolumne River.

The properties have been worked at intervals for many years and ore was milled last in 1914 by Paul Morris. The vein is quartz, and well defined, following in part a contact between black slate and granodiorite, and in part filling a fissure in granodiorite, and is associated with a diorite dike. Vein strikes N. 45° W. and dips 50° NE., and varies from 2 to 5 ft. in width. It has a good production to its credit in past years.

The principal workings are the Dead Horse shaft, over 1700 ft. deep on the dip of vein, and the Lady Washington tunnel, which is a crosscut meeting the shaft at the 1165 level, 2400 ft. from the tunnel portal, and from that point is a drift on the vein driven over 900 ft. at the time of writer's visit, and since extended farther. The shaft, which is said to have been full of water below the tunnel level for 20 years has been unwatered during the past summer for the purpose of opening a level at 1750 ft. and exploring the vein. Two shoots were

Photo No. 62. Mill of the Grizzly Mining Co. (formerly New Albany Mill), near Tuolumne.

worked formerly from the shaft to a depth of 1400 ft. and the levels above the Lady Washington tunnel are abandoned.

The reduction plant is nine years old and consists of twenty 1000-lb. stamps, 3 Frue vanners, 2 Hardinge mills and cyanide equipment.

The property has first right to water from the river and the supply is ample for power and milling except in the fall of very dry years. A 14-ft. Pelton wheel using water under 125 lb. pressure operates the air compressor. The mine is connected with the road by a tramway.

OTHER QUARTZ MINES AND PROSPECTS.

During the past summer there has been some prospecting on numerous properties in the southern end of the county and near Tuttletown, as noted briefly below.

Buckhorn Mine, being developed by California Packers Association. A contract to drive 150 ft. of drift was let during the past summer. It is in the Moccasin Creek district south of Jacksonville.

Boitano Mine, near Deer Flat. Six men employed and a 4-stamp mill being put up during the summer.

Harriman Mine. Harriman Mining and Milling Company, an Arizona stock company, capitalized for $500,000. This is a group of 3 claims located on Tuolumne River and on the Yosemite highway near Moccasin Creek. A small compressor was installed, and a shaft was being sunk during the summer, and was down over 100 ft. in August.

McCormick Mine. M. McCormick Co., Stockton, owner. Located south of Shawmut mine, and a mile and a half above Stevens Bar bridge. This property has been a producer of high grade ore in small amounts for over two years. It was first developed by an adit 1700 ft. long on the cañon side above the river and a winze was sunk on the vein. Later an adit 500 ft. lower was driven. There is a small mill on the property. The ore is rich in free gold.

Madelon Mine. J. W. Schiffman, P. E. Mertz, L. S. Grant et al., owners, Jamestown. Under bond to Henry Schmal, superintendent, and others, known as Associated Miners. The prospect is about 3 miles south of the Belmont Shawmut near Stevens Bar bridge.

There is an old shaft near the edge of the river, but Schmal has been driving an adit about 30 ft. above, and has found some good prospects.

National Mine. One mile northwest of Priests. Comprises 3 claims under bond and lease to National Gold Mines Company. There is an old shaft about 300 ft. deep on the property. The present company has done a little mining and has moved a second hand 10-stamp mill and mine equipment from the Champion property.

Patterson Mine. This old property at Tuttletown has been prospected by a winze from the tunnel level and some good assays have been reported during the past summer. A motor, air compressor of 500 cu. ft. free air capacity, blacksmith shop and small hoist have been installed. J. L. Witney, superintendent.

Tarantula-Gold Ridge-Reitz Group. This group includes the Tarantula mine adjoining the Belmont Shawmut on the north and other claims on which Henry T. Gage, former governor of California, had a bond for some time. Early in 1920 Gage transferred his interest to the Tuolumne Giant Gold Mines Company, of Los Angeles. Specimen ore was found in a drift driven at a depth of 80 feet from a shaft sunk 120 ft. on the vein on the Gold Ridge claim.

Preparations were being made in November to extend the Tarantula adit into the Gold Ridge, with the idea of tapping the vein at a greater

depth. Stock in the company is being sold in Los Angeles by the American Securities Company.

Verdun Mine. Solari, June, and Mangante, owners. At Stevens Bar Bridge and adjoins the Harriman mine. It was prospected by the owners who drove an adit 180 ft. long before bonding it early this year. A little work has been going on the past season.

DRIFT MINES.

Little placer mining has been done in the county the past year. Most of the work of this kind has been on the Table Mountain channel system which has been mined since 1850.

Monarch Gravel Mine. Owners, Mr. and Mrs. A. H. Hiatt and Frank B. Hiatt of Confidence; leased to Monarch Gravel Mining Company, Jerry Casey, secretary, 510 Page street, San Francisco. This prospect is in section 4, T. 2 N., R. 16 E., 2 miles north of Confidence at an elevation of 4500 feet.

Work has been done during the summers for several years past. A main tunnel had been driven 1800 ft. and a branch tunnel 455 ft. in rotten granodiorite. At 1200 ft. in, a raise was put up 15 ft. and a drift was run in rather fine gravel for 200 ft. parallel to the main tunnel. This gravel was said to carry $1.50 to $2 a car. They also had fine gravel in the roof of the branch tunnel when visited. It appeared at that time that they had only encountered the rim of channel, the direction and size of which was not known.

There is an Ingersoll Rand air compressor, 9″ x 8″, a 35-h.p. Samson gas engine, small blacksmith shop and machine drills on the property. There is good timber on the property and a water ditch ¼ mile distant.

Springfield Drift Mine. Springfield Tunnel and Development Company, Sonora; J. S. Cademartori, superintendent. Property comprises 1198 acres about 1 mile south of Columbia in sections 9, 10, 15, 16 and 22, T. 2 N., R. 14 E. Elevation at new drain tunnel portal is 2029 feet and at new Richards shaft is 2300 feet.

Portions of the property have been worked off and on since 1852 when pay gravel was discovered on the Fox claim in a shaft only 8 ft. deep. The first tunnel to find gravel under the basalt cap was started in May, 1854, and reached the channel in October, 1855. The Joint Stock, Springfield, Buchanan and other workings, all were extensively opened in the fifties and sixties.

Some years ago this company planned to drive a tunnel 6000 ft. long from the Stanislaus River slope for the purpose of draining the heavy flow of water which hampered shaft sinking. This tunnel was abandoned. In its place a new drain tunnel was started which has its portal a little west of the Saratoga drain tunnel. This tunnel has been completed to the new Richards shaft, 3000 ft. north. It is planned to extend it to No. 2 shaft, 1300 ft. northeast of Richards shaft, as soon as funds are available. In a portion of the tunnel 800 ft. of tarred iron drain pipe 16 inches in diameter was laid and the tunnel was permitted to cave after protecting the pipe. Most of the tunnel was in limestone. It is 5 ft. wide, 6½ ft. high and is said to have cost $12 a ft. It has a grade of ½ of 1%.

The gravel is covered with an average of 180 ft. of latite and andesite and 12 ft. of pipe clay. A series of 30 Keystone drill holes have been driven on the property and the reported returns from some of these are encouraging. All these are quite a distance north of the Richards shaft which is the present working entry. A fine prospect was reported from No. 3 shaft, on the Barry channel, 1500 ft. north of Richards shaft. While working in No. 3 shaft some years ago the superintendent reports he and several miners narrowly escaped drowning when caught by a sudden rush of water and were unable to properly prospect the ground. Three drill holes in the Barry channel near this shaft gave very high returns.

The superintendent believes there are four channels which enter the main Table Mountain channel from the northeast on the property. This belief is based partly on the drill returns. Just where they enter the main channel is conjectural, as there is a great deal of ground unexplored. Looking north, the supposed channels are named as follows from west to east: Table Mountain, Buchanan, Fox, Barry, Slaughter House. Widths indicated by the drill were: Buchanan, 600 ft.; Fox, 60 ft.; Barry, 200 ft.; Slaughter House, 17 ft. The Barry channel where drilled was 62 ft. deeper than the Fox and Buchanan, which may be bench deposits. The drain tunnel passed under the Table Mountain channel and raises were put up into the gravel but it was said to be too low grade to mine. Richards shaft is 265 ft. deep; No. 2 shaft, 242 ft.; No. 3 shaft 279 ft.; O'Hara shaft 230 ft. and old Ranch shaft 125 ft. deep; besides these, there are numerous old workings.

During October and November, 1920, they mined some rim gravel off the old workings 200 ft. north of the Richards shaft. This work was incidental to driving the tunnel ahead to No. 2 and No. 3 shafts and it is hoped the returns will help pay for the tunnel.

The property is equipped with a barrel mill, 2 stage Byron Jackson centrifugal pump, hoist operated by 37-h.p. motor (at Richards shaft), 12″ x 12″ Sullivan air compressor operated by 50-h.p. motor, an old compressor 10″ x 12″, and 2800 ft. of electric power line. Water for milling is pumped from an old shaft.

GRANITE.

Sonora Granite Company. J. E. Hunt, manager, Sonora, California. Located on the Rablen Ranch, near Sonora. Late this fall, the compressor, hoist, other machinery and buildings at the Garfield Mine on the Tuolumne River were being moved to the Rablen Ranch for use in quarrying granite.

LIMESTONE.

Pacific Lime and Plaster Company. Quarry and plant 1 mile south of Sonora. This company was preparing to use wood instead of oil for fuel a few months ago. They produce burnt lime and raw, crushed and ground limestone for industrial and agricultural uses.

MARBLE.

The marble resources of the Columbia district and the adjacent portion of Calaveras County are inexhaustible. The reasons that have

retarded their development are cost of transportation and the prejudices of architects and builders, who are gradually being educated away from the idea that California marble is inferior to that brought in from other states and Alaska or from foreign countries. The cost of getting the home product to market is decreasing with the improvement of roads and development of motor transportation. Increasing transcontinental and ocean freight rates have helped the local producers, notably as regards competition with Alaskan marble, which before the war could be delivered from the coast of Alaska to San Francisco for $1 a ton, as against $3 a ton from Sonora. It is to be hoped that California producers can establish themselves in the market during the readjustment period, and show builders that the domestic supply is always available and of high quality.

Bell Marble Company. Ed. Parke, J. B. Warner and Ed. Hill, owners. The property is lot 18 in Columbia townsite and contains 25 acres, with a known area of marble 350 ft. x 700 ft. This company has been operating since December, 1918. The pit was 40 ft. deep when visited.

Marble in rough blocks containing 6 to 14 tons each is broken out by jackhamers and plug and feather and shipped to San Francisco and Oakland firms. The product varies from pure white to dark veined. It is 80% $CaCO_3$ and 16% $MgCO_3$ and weighs 169 lb. per cu. ft. and has a compressive strength of 22,000 lb. per sq. inch, as compared with 16,000 lb. per sq. inch for the Alaska and Vermont marbles with which it competes. There is about 20% waste in quarrying. Hauling from the quarry to Sonora has cost $2.25 a ton on contract, but can be done cheaper.

The quarry is equipped with a Washington derrick hoist, 15 tons capacity, operated by compressed air; a 75-h.p. motor, Rix air compressor, 350 cu. ft. capacity, and 2 mile electric power line. The output could be largely increased with the present outfit if business warranted.

Columbia Marble Company. W. D. Bannister, Columbia, president and manager. The property contains 160 acres, all presumably underlain by marble and is situated on the cañon side of North Fork of Stanislaus River in sections 2 and 3, T. 2 N. and section 34, T. 3 N., R. 14 E. 3 miles from Columbia and seven miles from Sonora, at an elevation of 1500 ft. The quarry has been worked since 1891.

This property produces a fine quality marble, in any color desired from white to dark veined and black. There are also 2 grades of Portola marble produced; this is a beautiful buff stone with reddish veining. It was used in the Union Trust Building in San Francisco. The product of this quarry is considered equal to any in the country and as regards durability and strength is superior.

The old pit is 150 ft. wide, 200 ft. long and 80 ft. deep. In winter it catches a great deal of water which has to be pumped out at heavy expense, and so this pit is to be abandoned. A new pit is being opened 1200 ft. west of the old one and directly over the river, for convenient drainage. The marble is blocked out with an air drill and channeler and broken with plug and feather. The large blocks are broken into small ones weighing about 15 tons each, which are hoisted from the pit by a derrick. An Ingersoll Rand portable drilling outfit is used.

This consists of an air drill, 5-h.p. electric motor, and small compressor direct connected to the drill, the whole outfit being mounted on wheels, and easily moved about. The drill is mounted on a quarry bar and is said to drill 140 ft. a shift with about $2\frac{1}{2}$ h.p.

The 15 ton blocks are trammed from the derrick to the 8 Merriam gangsaws, which are operated by electric power and use sand for sawing. They saw the marble into slabs an inch thick. A tractor hauls loads of ten tons each to the railroad at Sonora at a cost of $2.50 a ton. The company has its own plant for generating electricity.

This quarry has been worked at only part capacity lately because of the depressed condition of the building industry. The marble deposit is 200 feet wide, 800 feet deep and a mile long and is estimated to contain over 200,000,000 cubic feet.

The **Baxter Marble Company,** 3 miles northwest of Sonora, the **Sonora Marble Quarry,** 1 mile north of Sonora, and the **Warren Marble Quarry,** $3\frac{1}{2}$ miles northwest of Columbia, have all been idle recently.

YUBA COUNTY.

There is not much change in mining to record in this county for the past year. Due to the operation of dredgers in the Yuba River at Hammonton, Marigold and Parks Bar, this county is the leading gold producer in the state. Aside from the dredgers, there is a little hydraulic mining in the Camptonville district.

GOLD DREDGERS.

Marysville Dredging Company. Home office in Boston, Massachusetts. Property and dredgers at Marigold, about 8 miles northwest of Marysville, on Yuba River. This property was operating three dredgers in 1917, but late in 1920 operated only one. Two of their dredgers had 9-cu. ft. buckets and one has 16-cu. ft. buckets. One of the smaller boats is out of commission and the other was expected to go out of use in 1921. The dredger with 16-cu. ft. buckets has a capacity of 750 cu. yds. an hour and has a crew of 18 men. The ground varies from 45 ft. to 66 ft.; the average being about 65 ft. deep. The company in 1917 had 500 acres left to dredge, giving them about 10 years life. The gravel is rather low grade in gold and carries some platinum.[1]

Pacific Gold Dredging Company. Office 528 Market street, San Francisco. Dredge near Parks Bar on Yuba River. This company operates one dredger with buckets of 9 cu. ft. capacity and capable of digging 70 ft. below the water line. This property is on the upstream end of the Yuba dredging field and the ground is rich. The dredger has been in operation since 1916.

Yuba Consolidated Gold Fields. Home office 50 Congress street, Boston, Massachusetts; Geo. L. Huntress, president; R. E. Paine, secretary. Property and plant at Hammonton, 12 miles northeast of Marysville, on Yuba River.

Operations in this district were described in 1917 by the writer.[2] The company has about 3000 acres, covering the channel for a length of 5 miles and a width of ½ to 1 mile. The gravel varies in depth from 25 to 100 ft. About 2000 acres have been dredged and 219,000,000 cubic yards have been handled up to November, 1920. In the annual report for the fiscal year ending February 28, 1920, the yield was said to be 13.66 cents a cubic yard and cost was 6.67 cents a cubic yard. This indicates a decrease in value per yard, although the yardage handled that year was the largest yet. The operations up to June 30, 1920, revealed a further decline in yield per yard to 11.22 cents. Yield for the year ending February 28, 1920, was $3,212,213.

The company is now operating 2 dredgers equipped with 7-cu. ft. buckets and 6 dredgers with 17-cu. ft. buckets. There has been some interruption to dredging, as well as to other forms of mining, during the past autumn on account of power restrictions. Some of the dredgers are equipped with a stacker on each side to permit easier operation when working in the channel, which has to be left clear under the rules of the government; tailings are stacked on each side, leaving an open lane at the rear, in the channel.

This company is the largest single producer of gold and platinum in the state.

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[1]See "Platinum and Allied Metals in California," by C. A. Logan; Bulletin No. 85, California State Mining Bureau.

[2]California State Mining Bureau, Bulletin 85: Platinum and Allied Metals in California, 1918.

REDDING FIELD DIVISION.

By C. McK. Laizure.

Part I.

SCOPE OF THE INDUSTRY.

The Redding Field Division embraces the following eight northern counties: Del Norte, Humboldt, Siskiyou, Trinity, Shasta, Tehama, Modoc and Lassen. Of these, Shasta, Siskiyou and Trinity have been recognized for many years as preeminently mining counties. The mineral resources of Del Norte and Humboldt on the west have not been developed to the same extent but they rank as important producers and during the war contributed largely to the 'war mineral' output of the state.

Stockraising, dairying, mining and lumbering are the chief industries in Lassen and Modoc counties. Mining became active in Tehama County during the war, the value of its mineral production jumping from $300 in 1914 to $157,591 in 1918.

The group, as a whole, forms one of the most important mining sections of the state, from the standpoint of actual production. At the same time, due to its large area, much of it unsettled and largely unexplored and the diversity of its mineralization, it probably contains more latent resources and offers more opportunities for successful development along mining lines than any other portion of the state of equal area.

The principal minerals mined are, copper, gold, platinum, silver, zinc and pyrite. The last report of the statistical department shows that Shasta County alone produces commercially sixteen different minerals. If petroleum is not taken into account, it leads all other counties in the state by a considerable margin in the value of its mineral products. Until 1919, when, owing to the Mammoth Smelter being closed, the copper production of Plumas County exceeded that of Shasta, the latter ranked first in copper, second in silver, first in pyrite, first in zinc, and seventh in gold.

Other minerals produced to a greater or less extent in the Northern California field division are: asbestos, barytes, bismuth, cadmium, chrome, clay, coal, gems, graphite, iron-ore, lead, lime and limestone, manganese, molybdenum, mineral water, natural gas, potash, pumice, quicksilver, salt, volcanic ash, marble, granite and miscellaneous stone. There are also undeveloped occurrences of mineral paint, gypsum, sulphur, talc and soapstone. Petroleum has been known to exist in Humboldt County since as early as 1860.

Further development of the Humboldt field is in progress and drilling has also been started during the year in Tehama County where it is hoped to develop a commercial field.

GENERAL CONDITIONS DURING PAST YEAR.

To say that the condition of the mining industry during 1920 was abnormal, is trite. It was, and still is, without precedent.

The past season has added one more to a succession of dry years marked by light snowfall in the mountains and little rain. The consequent shortage of water, which frequently extended even to the

drying up of springs used for domestic purposes during many years, and the acute shortage of hydro-electric power, has deterred mining to a great extent. Lack of water has particularly affected hydraulic and placer operations, but quartz mills and cyanide plants have also been compelled to shut down on account of insufficient water for mill use and power.

Most of the dredges have had sufficient water to meet their digging requirements but some have been severely handicapped by the low stage of the streams.

Enforcement of government power restriction measures affected all branches of the industry purchasing power, with few exceptions, so that even diamond drilling for exploratory purposes and gold dredging operations that might otherwise have proceeded at full force were limited for several months to the use of power between the hours of 5 p.m. and 8 a.m.

The monetary and financial conditions faced by the civilized nations of the world since the great war are not comparable with any in history. The position of the United States is probably better than that of any other nation, but even this country has suffered severely from the depreciated value of gold, measured in terms of commodities. This depreciation has resulted in excessive production costs due to the high price of supplies and high wage scales. The latter brought with it an indifferent attitude among skilled and unskilled labor and individual efficiency became low. Such conditions were particularly burdensome to the gold miner. The fixed price of his product prevented the gold producer from increasing his profit to meet the excessive costs of production and as a result the gold mines have been practically forced to close down to avoid operating at a loss.

Gold production for 1920 will reach a most discouraging low figure in this district. The dredging companies will be about the only operators whose figures will compare with normal output. There is little likelihood of there being any appreciable increase in gold mining except as it may gradually revive with the slow return of more normal or pre-war conditions, or as it responds to legislative measures now being urged before Congress. Proposed measures that have received the greatest consideration are embodied in the McFadden bill, an act designed primarily to prevent depletion of the country's gold reserve by placing an excise tax of $10 per ounce on all gold used in the arts and manufactures, and the payment, from this tax fund, of a premium of $10 per ounce on all new mined gold.

As the amount of gold consumed in this country in the arts and manufactures in 1919 exceeded the total production by over $20,000,000 and the estimated excess of consumption over production in 1920 is not less than $30,000,000, it is obvious that some action must be taken to either stimulate production or curtail withdrawals, if the gold standard is to be maintained in this country. The McFadden bill, if passed, will not affect the monetary value of gold in any way. It is anticipated that the $10 premium will enable many mines, now closed, to operate at a profit and so increase production as to relieve the country from any danger to its reserves, and at the same time preserve the gold mining industry from impending disaster. Reports

from the field indicate that considerable prospecting has begun solely on the strength of the belief that the McFadden bill will become law.

With the exception of the eight dredges, equally divided between Shasta and Trinity counties, that have been kept in commission, though for the most part on a reduced time basis, gold mining has been almost 'dead' in this district during the past year. One or two hydraulic and placer workings in Siskiyou and Trinity counties were more or less active. A few small pockets were found in Trinity and Shasta, usually by leasers working alone, and a stamp mill or two managed to operate at least a portion of the year. Beyond this, 'assessment work only' has comprised the year's gold mining record.

COPPER.

The Shasta copper belt, extending in a semicircle nearly thirty miles long, north of, and within 25 miles of Redding, contains the most important copper ore deposits so far developed on the Pacific Coast. To these is due the fact that for a decade or more Shasta County has ranked first in the state in the value of metallic wealth produced. Due to the closing of the Mammoth Smelter, the production of copper from the Shasta County mines fell from 25,294,590 pounds valued at $6,-247,764 in 1918 to 8,673,342 pounds valued at $1,613,242 in 1919. Figures for 1920 are not available but the low figures of 1919 will be still further reduced by the closing down of the reverberatory furnace of the Afterthought Copper Company, in February and practical cessation of all copper mining in the county. It is difficult to see where there will be any appreciable output beyond that recovered from the leaching of the pyrite cinder, at the plant of the Mountain Copper Company in Martinez, obtained from pyrite ore mined for its sulphur content and containing on an average only about .7% copper.

Other important copper districts are being developed in Siskiyou and Trinity counties and there are excellent prospects in Humboldt, Del Norte and Lassen. Both the Gray Eagle and Blue Ledge mines in Siskiyou County are developing large ore reserves and the latter is shipping to the Tacoma Smelter.

In Shasta County the Mammoth Smelter of the United States Smelting, Refining and Mining Company has been shut down during the entire year. Development has been carried on, however, at the Mammoth and Keystone mines of the company by both surface and underground diamond drilling and large ore bodies have been proven. At the Keystone mine 25 to 30 men have been employed. Some of the ore developed here is said to run very high in gold. During the year the company closed an option on the Crystal Group of 24 claims, lying north of the Balaklala. They have also acquired the entire holdings of Holt and Gregg, consisting of limestone quarry, limeworks, and electric railway. No date has been set for the resumption of smelter operations. This will depend on conditions governing operating costs and the copper market.

The Balaklala Consolidated Mining Company's ores are sent to the Mammoth plant for smelting. Since the shut-down of the smelter the Balaklala mine has been closed. The company has large ore-reserves blocked out and is in a position to produce ore whenever the smelter is ready to receive it.

The Iron Mountain Mine of the Mountain Copper Company has been closed down during the year. Production of copper will not be resumed until there is a more stable market. The company, however, has continued to produce from 400 to 500 tons of pyrite ore daily from the Hornet mine, the only one of the group being worked. The ore is marketed, chiefly for its sulphur content, which averages from 45% to 48% with copper less than 1%. A new plant with a capacity of 600 tons per day, designed for the fine crushing of pyrites was completed and put in operation in October. Additional cottages for employees are being built.

The Afterthought Copper Company closed down its oil flotation plant and reverberatory furnace in February and laid off its large force of men for an indefinite period. Production had not been resumed up to the end of the year.

One of the most important deals in the history of the copper belt was consummated this year when Daniel C. Jackling and associates took over a half interest in the famous Bully Hill group of mines. Development work at Bully Hill has been carried on for the past three years at their Rising Star mine, where some 300,000 tons of ore are blocked out. A new company, known as the Shasta Zinc and Copper Company has been organized, of which D. C. Jackling is managing director.

The Shasta Zinc and Copper Company is erecting a new plant at Bully Hill for the production of copper matte and zinc-oxide from their copper-zinc ores. With 125 men employed on construction, rapid progress is being made and it is expected that the new plant will be ready for operation in March, 1921. For the present the oil flotation mill will remain shut down.

The above five companies produce practically all of the copper and zinc ores of the Shasta belt. Although actual production for 1920 will be almost negligible, due to the development work carried on, the mines will be in a stronger position than before, whenever conditions warrant resumption of mining.

Drilling for exploration and development purposes is being carried on at the Shasta May Blossom property near Bully Hill. P. J. Healy of New York has the contract for drilling. Work was commenced in September, a Calyx chilled-shot core drill being used.

On the West belt, the Pittsburg and Mount Shasta Gold Mining and Milling Company is making the transition from gold to copper mining. The property adjoins the Mountain Copper Company and was long operated as the Little Nellie gold mine. In a crosscut running northwest for over 3000 feet, alaskite porphyry was encountered carrying chalcopyrite. Diamond drilling demonstrated the chalcopyrite at points 500′ to 700′ below the adit level. A new vertical 500′ shaft was then sunk at the end of the adit. It was completed during the summer and a crosscut started from the bottom of the new shaft. No definite copper ore-body has as yet been reached but copper sulphides are encountered in fracture planes and joints and the geological conditions are considered extremely favorable. This is the deepest working on Iron Mountain.

The famous Uncle Sam gold mine in the Squaw Creek district, the Alice, Snyder, Croesus and Clipper claims, adjoining, and the Colma

copper group, have been bonded to the American Zinc, Lead and Smelting Company of St. Louis. They are being developed for copper and zinc.

The Greenhorn mine of the Atascadero Copper Company has been idle during the year.

In Lassen County the Cooper Hill Mining Company let a contract for a 1000-foot crosscut tunnel to prospect their copper deposits near Westwood. The occurrence is similar to that at the Engels mine.

PLATINUM.

The production of platinum which is obtained from the dredges, hydraulic and placer mines in conjunction with gold, will probably show a slight falling off following the decline in gold mining. The high price obtained for the platinum group metals, however, is an inducement to prospectors and a good many are making a specialty of searching for platinum deposits. This activity and the closer saving practiced by the dredging companies may offset any decline due to fewer hydraulic and placer operators.

A recent shipment of 32 dwt. obtained by a man working alone with a pan on upper Beegum Creek, Shasta County in less than thirty days, assayed 25 dwt. osmiridium, 1 dwt. gold, 6 dwt. platinum. The high percentage of osmiridium in the metal from Beegum Creek adds considerable to the value of the product. At the present writing iridum is quoted at $400-450 per oz., osmium $75 per oz. and platinum $105 per oz.

SILVER.

A market price of $1 per oz. for domestic silver is now guaranteed by the government. Purchase of silver up to a total of 207,000,000 oz. at the above figure is provided for by the Pittman Act. Up to October, 1920, 16,000,000 oz. had been purchased. Figured at the average yearly rate of 50,000,000 oz., this price will hold for from three to five years, and there is some likelihood of its being extended at the end of that period. Without restriction the market was for a time considerably above $1 and later below that figure. At $1, the price shows an increase of 73% over the pre-war price in 1913 and it is considered fair.

The normal output of silver in the northern counties is considerable, but it is largely obtained as a by-product from silver-bearing gold, copper, lead and zinc ores. The closing down of the Mammoth Smelter will greatly curtail silver production for 1920. Besides cutting off the by-product silver, it leaves no market nearer than the Selby Works on San Francisco Bay, for ores that could be produced primarily for their silver content at the prevailing price of that metal.

Renewed interest is manifest in the old silver mining district near Igo, Shasta County, where development work has been carried on at a number of the mines, among them the Big Dyke and Silver Falls. Some production is likely in the near future.

ZINC.

Zinc ores are associated with the copper bearing ore-bodies of the Shasta belt particularly on the east side at Bully Hill and at the Afterthought mine.

The production of zinc for 1920 will be very small, following the decline in copper mining. At both the Shasta Zinc and Copper Company's mines and at the Afterthought mine, selective oil flotation processes have been successfully operated, and a separate zinc and copper concentrate produced. As it is impossible to ship the zinc concentrate to eastern smelters at a profit, due to excessive freight and treatment charges, they have been stored pending the erection of electrolitic zinc plants or zinc-oxide works. The Shasta Zinc and Copper Company has a plant well under way for the production of copper matte and zinc-oxide, which it is believed will solve the metallurgical and market problems involved.

PYRITE.

The **Mountain Copper Company** has continued to produce in the neighborhood of 500 tons of pyrite ore from the Hornet Mine daily throughout the year.

IRON ORE.

The **Noble Electric Steel Company** has shipped an average of 500 tons of iron ore per month from its mines at Heroult, Shasta County, to various Pacific Coast points between Los Angeles and Seattle.

QUICKSILVER.

Ten men have been employed at the **Hutton Quicksilver Lease,** near Gottville, Siskiyou County. A 25-ton rotary furnace is to be installed. This is the only quicksilver mine being developed in this district at the present time.

CHROME AND MANGANESE.

There has been no activity in these metals.

OTHER MINERALS.

The year 1920 will show only a nominal production of the minor metals and non-metallic products, such as asbestos, barytes, clays, limestone, mineral water, natural gas, potash, pumice, salt and miscellaneous stone.

Among the above, mineral water will probably rank first in value. It is an important item, the famous Shasta Springs being in Siskiyou County.

During the year shipments were begun from a deposit of potash bearing rock near Ager, Siskiyou County. It is said that this rock contains 5½% of potash. Samples submitted to the Bureau gave a good potassium test.

GENERAL OUTLOOK FOR COMING YEAR.

Mining in this district is confined principally to the two great basic metals, gold and copper, and activities during the coming year will be governed to a very great extent by general conditions throughout this and other civilized nations.

The only bright spot on the horizon for the gold miner is the McFadden bill. In the hope of its being passed some interest is again being taken in prospecting. Even if it becomes a law there are still many properties that will have difficulty in operating at a profit. Taking the general run of quartz properties in the northern gold producing counties and it is apparent that, under present conditions, ore running less than $50 per ton is practically valueless.

The copper situation presents a different view. Copper producers made extraordinarily large profits during the war, and the present stagnation in production appears to be only a natural aftermath resulting from forced depletion of reserves, abetted by a weak foreign and domestic market. According to a statement issued by the government, some 574,000,000 pounds of copper were recovered during the past year from new and old scrap alone. Under such conditions there is no incentive for other than minimum production.

It will take some time for the disjointed affairs of the world to become straightened out, but with the change in political parties at home, it is the consensus of opinion that our international affairs will become stabilized and that 1921 will see the beginning of a new commercial and industrial cycle. The industries in this country that absorb copper are growing and as new capital becomes available the demand for the red metal is certain to expand; while the hoped-for solution of our international commercial relations will open the way for copper exports on a large scale.

An engineer, identified for the past three years with large copper interests operating in Chile, recently made the statement that operators there expected to see 40¢ to 50¢ copper within three or four years. Although the premises on which this prediction was based, were not stated at the moment, it serves to indicate the pervading undertone of optimism in the copper mining industry.

The quiet development work carried on at the mines, acquisition of new territory, injection of new capital and improved metallurgical plants being erected by the copper producers of this district during the period of curtailed output, will place them in an excellent way to take full advantage of the demands for the metal which it is generally believed will develop in the reconstruction period, after the present slump.

GEOLOGICAL NOTES.

The supervisors of Shasta County are having a series of maps made covering the west belt of copper deposits from the Mammoth on the north to the Mountain Copper Company's holdings on the south. One series shows the ownership of all claims with the topography of the area, and a second corresponding series shows the areal geology and indicates the position of the various formations. The maps are being

prepared by Mr. M. E. Dittmar and are for the purpose of determining an equitable valuation basis for tax assessments.

The plates are in color and to a scale of 1000 feet to one inch. Owing to the large scale used and detail shown, they make a valuable addition to other geological studies of the west belt.

TRANSPORTATION; POWER; WATER; CLIMATE.

State highway construction and county road building have progressed throughout the year. Improved transportation facilities are one of the basic needs of the mineral industry in the northern counties.

The principal copper camps of Shasta County have railroad connection, usually privately owned, with the main line of the Southern Pacific. In Siskiyou County, the copper camps are less fortunate. At the Gray Eagle mine of the Mason Valley Mines Company, at Happy Camp, over 1,000,000 tons of low grade ore have been blocked out and await the construction of a railroad down the Klamath River. The Blue Ledge mine, which is shipping copper ore to the Tacoma Smelter, is compelled to haul 33 miles to Jacksonville, Oregon, to get rail connection. Del Norte, Humboldt, Siskiyou, Trinity, Modoc and Lassen counties are very largely dependent on motor trucks for their supplies. The Redding-Weaverville lateral, Klamath River highway, and Redding-Alturas lateral, when completed will be kept open the year round and materially reduce transportation costs.

Reports from Modoc County state that work is expected to begin in 1921 on the extension of the Fernley-Lassen branch of the Southern Pacific from its present terminus near Westwood, Lassen County, to Klamath Falls, Oregon. The proposed route is through western Lassen and Modoc counties.

Hydro-electric power development now under way in the northern counties will greatly benefit the mining industry, both directly, by furnishing a most flexible and economic motive power, and indirectly by making available electro-metallurgical reduction processes and by building up electro-chemical industries, which, in turn, require a variety of raw mineral products whose production will be stimulated.

The growth of chemical and electro-chemical industries has been rapid in this country during and since the war. Engineers have pointed out that these industries could be established by the power companies themselves, or by subsidiary, or independent companies and adapted to use electric power only at the time of high water or daily during periods of minimum loading on the line, so that a very cheap power rate could be obtained. Compared to the East but a small proportion of the electric power on the Pacific Coast has been developed for industrial purposes. These industries would be of advantage to the power companies. At the same time they would create a market for various mineral products, many of which are abundant and in close proximity to the generating plants, and be the means of building up manufacturing communities.

Both the California-Oregon Power Company, whose transmission lines are mainly in Siskiyou County, and the Shasta Division of the Pacific Gas and Electric Company, are engaged on construction programs. The ultimate plans of the Pacific Gas and Electric Company

call for an expenditure in the neighborhood of ten million dollars for power projects on Pit River, Fall River and Hat Creek. Construction of Plant No. 1 on Pit River at Sheep Rocks is under way. Here 60,000 h.p. will be generated and a like amount at Plant No. 2 farther up. The Big Bend project calls for an initial installation of 100,000 h.p. with an ultimate development of 375,000 h.p.

Water and timber are perhaps nowhere more abundant than in the Northern California field division. The drainage systems of western Siskiyou and Trinity counties are tributary to the Klamath and Trinity rivers which flow direct to the Pacific Ocean. In this area hydraulic mining may be carried on without restriction, on account of the silt question not affecting any navigable stream. Climatic conditions are excellent and below elevations of 2500 feet mining may be prosecuted in winter as well as summer without inconvenience. Above 2500′ in altitude snow is liable to interfere, to some extent, with work in winter.

Very heavy rains in November and December, general throughout this section, indicate a break in the abnormal dry seasons experienced for several years and promise abundant water for mining and power use during 1921.

LABOR.

Labor conditions changed materially for the better toward the latter part of 1920. One operator reported that he had had more applications for jobs during the two months of October and November than during the previous two years. A disposition to hold on to a job once obtained and to deliver a fair day's work is also becoming general. There is nothing, however, to indicate any immediate reduction in miner's wages and it is possible that employers will be satisfied with increased efficiency, at least until the cost of living has been unmistakably reduced.

OUTFITTING AND SUPPLY CENTERS.

Eureka and Crescent City are the outfitting and supply centers of Humboldt and Del Norte Counties. Yreka is the central distributing point in Siskiyou County, but camps near the northern boundary are more conveniently reached from Jacksonville, Oregon. Points in Tehama County are supplied most conveniently from Red Bluff. In Lassen County, Susanville and Westwood are the principal outfitting points. Alturas in Modoc County is the center for that section.

Redding, on the main line of the Southern Pacific Railroad and near the geographical center of the entire northern division, is the principal mining center. Large stocks of various supplies are carried by the local merchants. The main highway north and south, and the east and west laterals meet here. Unloading derricks for handling heavy dredge parts and mining machinery are available. There is a foundry and machine shops and an engineering and assay office. It is the outfitting point for Shasta County; and Trinity County, through Weaverville.

The office of the Northern California Field Division of the State Mining Bureau is located in Redding.

Part II.

Redding District: By Counties.

DEL NORTE COUNTY.

Del Norte County has an area of 1024 square miles and occupies the extreme northwest corner of the state.

It presents a wide field for development along mining lines, but is handicapped by lack of railroads and the inaccessibility of many of the deposits.

The county is traversed by the Coast ranges and is extremely rugged and covered with heavy forest.

Deep-seated granitic rocks form the core of the mountain ranges. These are blanketed by crystalline limestones, slates, quartzite and other metamorphics. The western portion is composed largely of sedimentary rocks. A belt of intrusive serpentine and associated rocks extends in a northerly direction through the county at a distance of from eight to ten miles from the coast. Farther east near the Del Norte-Siskiyou county line is another belt. These belts contain the most promising chrome and copper deposits. Quartz occurs in small veins and seams, the slates carrying many thin seams, sometimes rich in gold. Erosion of these formations is responsible for the concentration of gold in the streams.

Crescent City is the county seat and principal outfitting point. Freight service is furnished by small coastwise steamers, without regular schedules, that call at the port principally for the lumber trade.

From Eureka, on the Northwestern Pacific Railroad, in Humboldt County, the coast highway extends 99 miles north to Crescent City, thence to Grants Pass, Oregon, via South Fork, Gasquet and Patrick Creek, a distance of 95 miles. Road construction is expensive and many points can only be reached by trail.

During the war, chrome mining became an important industry and many deposits were opened up in the serpentine areas.

A table showing the mineral production of the county for 1917-1918-1919 follows:

Commercial production for 1917 was:

Substance	Amount	Value
Chromite	3275 tons	$97,255
Gold		1,373
Platinum	10 oz.	853
Silver		8
Stone, miscellaneous		2,700
Other minerals		2,151
Total value		$104,340

Commercial production for 1918 was:

Substance	Amount	Value
Chromite	7143 tons	$360,485
Gold		565
Platinum	1 oz.	97
Silver		4
Stone, miscellaneous		8,000
Other minerals		2,524
Total value		$371,675

Commercial production for 1919 was:

Substance	Value
Gold	$500
Silver	4
Stone, miscellaneous	6,300
Other minerals	67
Total value	$6,871

The chief mineral resources of the county are chromite, clays, copper, gems, gold, graphite, iron, platinum, quicksilver, silver and miscellaneous stone.

A description of the mines and prospects in Del Norte County is contained in the Fourteenth Report of the State Mineralogist. Under later date, Bulletin No. 76 describes the chrome properties and Bulletins No. 78 and No. 85 the quicksilver and platinum deposits, respectively. The possible occurrence of petroleum is discussed in Bulletin No. 89.

During the year 1920 there was very little mining activity in Del Norte County beyond doing assessment work, which is again required after three years' suspension.

With the exception of the field work done in connection with Bulletin No. 89 the county was not visited during the past season.

HUMBOLDT COUNTY.

Humboldt is one of the north coast counties. It has an area of 3634 square miles and lies between Mendocino on the south and Del Norte on the north. Its length, parallel to the coast, is about three times its width from east to west.

The county is mountainous, being more rugged in the northern part, where crystalline and metamorphic rocks predominate, than in the southwestern section, where sandstones and shales are prominent. The serpentine belt noted in Del Norte County passes southeasterly through Humboldt.

The general trend of the Coast ranges is northwest-southeast and the streams which enter the Pacific all flow in a northwest direction, parallel to the strike of the sedimentary formations which form a large portion of the mountain masses.

The Northwestern Pacific Railroad, which terminates at Eureka, gives direct rail connection to San Francisco. Eureka, the county seat and largest city, is also a port for coastwise shipping. The county still lacks much in transportation facilities. It is noted as a lumbering, dairying and agricultural territory, but it also contains a notable variety of mineral deposits and though not of large size as a rule, and but partially developed, the county has ranked as an important producer for many years.

Commercial production for 1917 was as follows:

Substance	Amount	Value
Gold		$23,086
Platinum	6 oz.	351
Silver		95
Stone, miscellaneous		27,014
Other minerals*		9,312
Total value		$59,858

*Includes brick, clay, mineral water, natural gas, and volcanic ash.

Commercial production for 1918 was as follows:

Substance	Amount	Value
Chromite	370 tons	$21,744
Clay (pottery)	210 tons	420
Gold		8,028
Granite		116
Manganese	1520 tons	57,751
Natural gas	640 M cu. ft.	85
Platinum	2 oz.	140
Silver		72
Stone, miscellaneous		51,082
Other minerals*		2,516
Total value		$141,954

*Includes brick, mineral water, and pumice.

Commercial production for 1919 was as follows:

Substance	Value
Brick and clay	$9,271
Gold	8,000
Silver	50
Stone, miscellaneous	25,198
Other minerals*	1,148
Total value	$43,667

*Includes mineral water and natural gas.

Its resources include brick-clay, chromite, coal, copper, gold, granite, iron, mineral water, natural gas, petroleum, platinum, pottery-clay, pumice, silver, volcanic ash, and miscellaneous stone.

The Fifteenth Report of the State Mineralogist describes in detail the mines and mineral deposits of the county. In addition to the above report, and of later date, Bulletin No. 78 describes the occurrence of quicksilver; Bulletin No. 85 and Preliminary Report No. 7 cover the platinum occurrences and clay deposits, respectively, and Bulletin No. 76 discusses the manganese and chromite deposits.

Attention throughout the country during the past year has been drawn to the petroleum possibilities in new fields. The commercial production of natural gas and known occurrence of petroleum in Humboldt County has aroused special interest in this section and all field work in the county during the past season was directed to the investigation of the oil field. The results of this work are published in Bulletin No. 89.

Mining, in general, has been quiescent. A small amount of development work has been done and with few exceptions the annual assessment work, which is again required, has not been neglected.

The following notes on properties not mentioned in previous reports have been obtained through correspondence.

GOLD MINES—LODE.

Golden Eagle. Owner, Frank Schweichler, Orleans, California. This prospect was discovered in 1915. It is in the Red Cap mining district and is reached by a good road from Trinidad, the nearest railroad point. Elevation about 1000 feet, with abundant timber and water. The ledge is said to be sixteen feet wide, free milling, and to carry gold, silver and copper.

Prospect Hill Mine. Owners, C. S. Little and Prospect Hill Mining Company, L. I. Rowland, president; C. S. Daniels, secretary; home office, Orleans, California. Property consists of nine claims, the Doney, Ten Eyck, Wildwood, Martha, Martha Ex., Lucky Queen, El Portal and Norelle Merle, with a total area of 200 acres. The mine is located in the Orleans district in section 5, T. 11 N., R. 6 E., on the forest reserve, and it is plentifully supplied with red fir, sugar and yellow pine. The surface is composed of steep ridges and deep gulches, the workings being located at an elevation of 3000 feet. The water supply is limited.

The deposit consists of quartz veins, twelve in number. Diorite is the prevailing country rock. The principal vein averaged about two

feet in width with a maximum breadth of eleven feet. The foot and hanging walls appear to be a metamorphic shale. The vein filling is talcose in character and the quartz carries some iron and a small percentage of chalcopyrite. It is, however, largely free milling. The vein being developed has a strike of north 20°-25° east and a dip of about 50°. It is proven on the surface for 150 feet. There are several tunnels aggregating 700 feet in length. The greatest depth on the vein so far developed is 150 feet, this point being 100 feet vertically below the outcrop. One man is employed on top and three in the mine. The total production to date has been about $7,000.

PLACER—HYDRAULIC.

Cañon Bar Mine. Owner, Willie Norton Sr., Hoopa Valley, California. Nearest town, Weitchpec. Property is on the Indian Reservation and thirty-nine miles east of the nearest railroad point. It was discovered about forty years ago and has been piped off and on at different times. Has not been worked for the past eight years. The area is forty acres and the claims extend along the river channel, which here courses north-south, for about one-fourth of a mile. The pay gravel, which contains some boulders, has an average depth of four feet and a width of fifty feet. About one acre has been worked.

Elkhorn Mine. Owner, G. F. Willhite, Orleans, California. Property consists of 200 acres, containing bench gravels. The mine is located in the Orleans district at an elevation of 500 feet and is reached by trail having a 6% grade. The county is reconstructing this into a wagon road. Trinidad, the nearest railroad point, is 75 miles southwest. The deposit was discovered in 1915. Red Cap Creek furnishes the water supply. The ground is level and covered with timber, the mine being on the forest reserve. It is equipped with a ditch 4000 feet long, supplying water, under 110-foot head, to pipe and giant. Tailings are run into the river. There is a four-room house.

Livingston and Eveston Pocket Mine. This property was sold in 1918 to T. E. Ahlstrom, Ashland, Oregon, or Gottville, California.

SILVER.

Gettysburg Silver Mining Company. This company, with home office in Reno, Nevada, is reported to have three claims in the Sawtooth Range, four miles from Sulphur, on which a twenty-foot shaft has cut a four-foot ore body. The shaft is on the Litharge claim and the ore is said to average $35 per ton, the values being mostly in silver, with a little gold. The vein has been prospected for 1500 feet in length. The width is said to vary from four feet to ten feet and assays from $10 to $45 per ton.

LASSEN COUNTY.

Lassen County lies wholly east of the crest of the Sierra Nevadas. The western portion is elevated and rugged, being composed of a succession of short mountain ranges, heavily wooded and interspersed with valleys. The latter are frequently occupied by lakes. Toward the east, the elevation is lower and the country more barren. The valleys take on the character of alkali flats and the mountains change to straggling hills and isolated buttes.

As shown on the geological map of the state, by far the greater portion of the county is made up of volcanic flows, chiefly andesitic lavas and tuffs, with some basalt and rhyolite, mostly of Tertiary age. There are some small exposures of heavily bedded sandstones and shales, and gravels of lake origin. Quaternary deposits of unconsolidated clays, sands, gravel and desert wash comprise the balance.

The eruptive flows have practically covered all evidence of mineralization, and although there has been some prospecting in this section, from the early days, when Peter Lassen lost his life while searching for silver-bearing lodes, to the present day, only two districts have been developed to the producing stage.

The mineral resources of the county include copper, gems, gypsum, gold, mineral water, potash, silver, sulphur, volcanic ash and the stone industry. Gold has been the principal product and most of it has come from the Hayden Hill mining district.

The following table gives the commercial mineral production for 1917, 1918 and 1919.

Commercial production for 1917 was as follows:

Substance	Value
Stone, miscellaneous	$376

Commercial production for 1918 was as follows:

Substance	Value
Stone, miscellaneous	$800

Commercial production for 1919 was as follows:

Substance	Value
Stone, miscellaneous	$1,100

A description of the mines and mineral resources of Lassen County is contained in the Fifteenth Report of the State Mineralogist (1915-1916). The following notes on current development and new discoveries obtained during the 1920 season of field work, are intended to supplement the data contained in the earlier publications and bring them up to date.

COPPER.

Copper prospects have been developed in the district south of Coppervale, in T. 28 N., R. 10 E.

Cooper Hill Group. This group, comprising seventeen unpatented claims, having an area of 350 acres, was located in 1917. In January, 1920, the claims were taken over and development started by the

Cooper Hill Mining Company (Union Construction Company, of Oakland); home office, 717 Walker avenue, Oakland, California; E. Z. Humphrey, president; F. E. Smith, superintendent. The property is situated in the Mountain Meadows mining district in section 28, T. 28 N., R. 10 E., 9 miles southeast of Westwood, the nearest railroad point. A good auto road has been built from the Southern Pacific Railroad, at Westwood, to the property, which has an elevation of 5400 feet at the tunnel site. The claims are within the forest reserve and are timbered with yellow and sugar pine. Cottonwood Creek supplies a small flow of water throughout the year. The surrounding country is mountainous and rough.

Country rock is diorite and the deposit consists of metallic oxides, sulphides and some native copper, disseminated through fresh diorite in a mineralized zone, 500 feet to 600 feet wide and at least 3000 feet long. The copper ores, accompanied by silica, occur in fractures in the diorite mass. The mineralized zone strikes N. 80° W. and practically all the croppings show copper stains, with specks of native copper occurring in many places.

The most prominent outcrops are near the summit of the ridge, about 350 feet above the proposed tunnel site near the creek level. A gas engine, compressor and two machine drills have been purchased and a contract let for driving a 1000-foot tunnel south across the strike of the ore-body. This is expected to cut the ore at a distance of 300 feet from the portal.

The deposit is thought to be a continuation of the Engles copper belt, as it lies along the strike of the latter and about five miles distant. Surface indications are excellent and the deposit is expected to develop into a large low-grade copper mine.

GOLD MINES.

Blue Bell Mine. The Blue Bell mine, owned by H. P. Anderson, of Hayden Hill, was leased during 1920 to J. I. Dorsey, Hayden Hill. The mine was discovered in 1880 and worked spasmodically until 1910, after which it remained idle until the present lessee began work this season.

The old workings, consisting essentially of a glory-hole about 35 feet deep and 50 to 60 feet in diameter and shaft below it, are caved and inaccessible. It is stated that $60,000 was produced from a pocket in the glory hole and that there were several veins in the old workings. Property consists of one claim on the rugged southwest slope of Hayden Hill. The deposit is a filling of soft unconsolidated fault breccia of adjacent wall rock, in fractures penetrating the rhyolite tuffs composing the hill. Finely divided gold, much of it oxidized, occurs in the veins. A new 50-foot vertical shaft is being sunk south of the glory-hole, from which it is expected to crosscut the veins beneath the old hole.

All mining is done by hand drilling and hoisting by windlass and bucket, two men being employed. There is no reduction equipment at the mine.

Coyote Mine. Owner, H. P. Anderson, Hayden Hill, California. There is a fair road to the property from the railroad station at Likely,

32 miles easterly. The mine is located in section 36, T. 37 N., R. 9 E., at an elevation of 6776 feet, and there is some timber on the claim. Water is pumped from Williams Creek, 3½ miles distant. The claim covers 1500 feet of the lode and has a total area of 22 acres. The ore-body consists of a decomposed quartz vein in rhyolite country rock. A shaft has been sunk 65 feet and 110 feet drifted on the vein.

Eckart and Allen Group. Owners, Harn, Eckart and Company; F. Allen of Westwood, California. This group comprises ten claims, the June, June No. 1, No. 2, No. 3, and No. 4 (west group), and the Beatrice, Beatrice No. 1, No. 2, No. 3 and No. 4 (east group), having a total area of 200 acres. The property is situated in the Mountain Meadows district, in sections 19 and 20, T. 29 N., R. 10 E., at an elevation of 5725 feet. It is nine miles northeast of Westwood, at the foot of Fredonia Pass, and one mile from the highway between Westwood and Susanville. A good auto road connects the highway with the mine. The locality is marked by rugged hills and ravines, the average elevation being about 5700 feet. Yellow and sugar pine cover the claims and spring water is available.

The country rock is meta-andesite and the deposits so far prospected consist of a large gossan outcrop, exposed in the ravine and on the mountain about 300 feet above the valley. This gossan is said to carry a little over $2 per ton in gold.

A number of trenches and a 40-foot shaft have been sunk in the meta-andesite, following up the cañon and above the gossan outcrop. A few kidneys or irregular small pockets of talc and quartz were encountered, all of which gave low values in gold.

The owners are planning on sinking a shaft below the gossan in an endeavor to locate a ledge. There appears to be a fracture in the andesite on this property, which shows a well-defined hanging wall, with a filling of silicified brecciated wall rock. Equipment consists of a windlass and a few tools, all work having been done by hand drilling. Idle at time of visit.

Eclipse Mine. This mine was first opened over twenty years ago, but little work has been done. It is situated on the south slope of Hayden Hill, at an elevation of 5700 feet and has a total area of ten acres. Geo. McFarling, of Hayden Hill, owner; post office, Merrillville. Likely, on the Nevada-California-Oregon Railroad, thirty miles northeasterly, is the nearest railroad point. Susanville, on the Southern Pacific Railroad, is sixty miles to the south. The country rock is rhyolite tuff and the ore deposit is a soft, unconsolidated fault breccia, of adjacent wall rock, filling the fracture. The veins are composed of fine-grained quartz and breccia with soft, clay-like gouge carrying very finely divided oxidized gold.

The Eclipse vein is two to four feet in width. It strikes north-south and has a vertical dip. The total length on the property is 700 feet.

Development consists of two shafts. No. 1, sunk many years ago, is now caved. It is said to have been 100 feet in depth. Shaft No. 2 is located 150 feet south of No. 1. At a depth of 40 feet, a drift has been started northward on the vein, to connect with the old workings. This drift is in 125 feet and it is said that some fairly good pockets

have been struck, the vein, as a whole, averaging $10 per ton. The owner is developing the property alone, by hand mining, a windlass being the only equipment.

Gold Leaf Mine. A. H. Hartman is reported to have discovered and located the Gold Leaf Mine, a short distance east of Wendal on the Nevada-California-Oregon Railway. Silver occurs with the gold.

Gray Goose Mine. The Gray Goose, formerly known as the Hayseed, comprises two claims, the Gray Goose and Sunrise, with a total area of thirty acres. The property is located at an elevation of 6000 feet, near the summit of Hayden Hill, in section 36, T. 37 N., R. 9 E. It was discovered in 1873 and worked intermittently up to 1912. New development work was started in the winter of 1919-20. It is owned by J. S. Owens ($\frac{2}{3}$) and J. M. Arnatte ($\frac{1}{3}$), Hayden Hill, or Bieber; post office, Merrillville. There is no water at the mine, and the mill is located three miles below on Willow Creek. The deposit consists of fine-grained quartz and breccia veins with clay-like gouge filling fractures in the rhyolite tuff, composing the country rock. There are three well-defined veins on the property, the Brush Hill, Gray Goose and Sunrise. The ore is free milling, but the gold is very fine and often oxidized. New development work has been confined to the Gray Goose vein, on which there is a 250 shaft. At the 215′ level, a drift has been run N. 50° W., on the vein a distance of 80 feet, showing it to be 6 to 8 feet wide. It is stated that this will average $10 per ton.

The shaft is filled with water below this level. There is said to be virgin ground above. Mining is done by hand drilling and the ore is hoisted with a whim.

The mill on Willow Creek, three miles by wagon road below the mine, consists of ten 850-lb. stamps and cyanide leaching plant, in fairly good condition. Power was obtained from two Pelton water-wheels. The mine was idle at the time of visit, the owners wishing to dispose of it.

Juniper Mine. Owners, Juniper Mining Company, Hayden Hill; post office, Bieber; M. A. Maher, president; W. H. Paulk, secretary.

The property consists of one claim, the Juniper Quartz claim, containing 20 acres. The mine has an elevation of 5600′ and is on the gentle southwest slope of Hayden Hill, in section 36, T. 37 N., R. 10 E.

This property is an old one and the most famous one on Hayden Hill. It was taken over by the present company in January, 1919, and has been in continuous operation since. The deposit consists of decomposed quartz and soft unconsolidated fault breccia of adjacent wall rock, filling fractures in the country rhyolite tuff. The decomposed quartz and breccia veins have a clay-like gouge and carry very finely divided gold, occasionally oxidized. There are no sulphides present.

On the Juniper, the hanging wall is well defined, but the footwall is less clearly distinguished. Both are of rhyolite tuff.

The vein is from two to twelve feet in thickness, having an average width of four feet on the 100-foot level. It strikes N. 70° W. and dips northeast at an angle of 60 to 80°, with a proven length on the surface of 1500 feet.

The present pay-shoot follows the hanging wall. A streak twelve inches wide is reported to run $350 per ton. Across the four-foot width, the ore probably runs less than $30.00 per ton. This shoot was struck on the 200′ level of the new shaft. It has been drifted on 48′ westerly and is said to maintain its high-grade character throughout. The shaft is now being sunk to the 250′ level, where a drift will be run to block out the ore-shoot. The old workings are caved and abandoned.

The mine is equipped with an Atlas gas engine and Rix 2-drill compressor, jackhammers being used in shaft sinking. There is also a 25-h.p. Fairbanks-Morse gas engine hoist, good for 500′ depth.

A mill, consisting of 10″ x 12″ jaw crusher, ten 1050-lb. stamps and two amalgamating tables, was completed in April, 1920. Water for the plant is leased from the Lassen Mining Company. It is pumped from Willow Creek, a distance of three miles, water power being used to operate the pumps. The entire plant is said to have cost $40,000. It was shut down after a six weeks run, on account of not saving the values and tests are now being made to determine what treatment to use. A ton of ore shipped to the Selby Smelting and Lead Company, in June, netted $300.00. This property has produced to date about $1,200,000. Four men are employed sinking the shaft, working one shift per day. The Blue Bell Mine adjoins.

PETROLEUM.

The possible occurrence of petroleum in Lassen County was investigated during the year. The results of the field work and conclusions to be drawn therefrom are published in Bulletin No. 89.

POTASH.

Desert Products Company. This company is developing potash deposits on the shore of Honey Lake. A small production of potash has been made. C. A. Jacobson, president, care Mackey School of Mines, Reno, Nevada.

VOLCANIC ASH.

Anderson Ranch Deposit. A deposit of volcanic ash outcrops over an area of 20 acres or more on the Anderson Ranch, in section 24, T. 37 N., R. 9 E., about 15 miles southeast of Beiber. H. P. Anderson of Hayden Hill, owner; post office, Beiber.

The deposit consists of a heavy bed of white volcanic ash at least twenty feet thick, with an overburden of soil, except where it outcrops. A fifteen foot tunnel, driven along side of the Adin-Hayden Hill road is entirely in the ash. There is no other development work. It is thirty miles from Hayden Hill to Likely, the nearest railroad point on the Nevada-California-Oregon Railway, or sixty miles to Susanville, on the Southern Pacific. There has been no production. The ash is reported by the owner to contain less than 1% Fe.

A sizing test gave—

90.4%—100.
9.6% +100.

Moisture test—

	Percent.
Dry slime, Sp. Gr. 2.3	100.0
Calcined	87.5
Water	12.5

MODOC COUNTY.

Modoc County has never been a large producer of mineral products. Heavy lava flows cover most of the county and only two mining districts have been developed. The area, as a whole, is an elevated plateau, marked by a succession of valleys separated by volcanic ridges. The Warner Range, which separates the Goose Lake country from the Surprise Valley section, contains the highest peaks, some of which exceed 8000 feet.

The Nevada-California-Oregon Railway, commencing at Reno, Nevada, and extending to Lakeview, Oregon, passes through the county near its eastern side. Fairly good roads from the principal towns along the railroad reach the more remote parts. Stockraising and agriculture are the principal industries.

Comparatively little attention has been given to mining and only a small amount of prospecting, mostly by range riders, has been done.

The knowledge of this fact and the occurrence of some outcrops of diatomaceous shale and sandstone, which many regarded as oil producing formations, has drawn attention to the possible importance of the undeveloped mineral resources of the county and increasing interest in their development was plainly manifest during the past year.

The known resources of the county include clay, coal, copper, gold, iron, mineral water, quicksilver, salt, silver and miscellaneous stone. The writer was recently shown a fine specimen of galena, the size of a walnut, said to have been picked up by a cattle man. Indians are reported to frequently come in with chunks of it, but its origin is unknown. The galena is practically pure and carries no silver.

The following table gives the commercial mineral production of the county for 1917, 1918, and 1919:

Commercial production for 1917 was as follows:

Substance	Value
Stone, miscellaneous	$200

Commercial production for 1918 was as follows:

Substance	Value
Stone, miscellaneous	$200
Other minerals*	8,020
Total value	$8,220

*Includes gold, salt, and silver.

Commercial production for 1919 was as follows:

Substance	Value
Stone, miscellaneous	$550
Other minerals*	8,120
Total value	$8,670

*Includes gold, salt, and silver.

The Fourteenth Report of the State Mineralogist contains a general description of the mines and mineral deposits of Modoc County. Quicksilver prospects are referred to in Bulletin No. 78, of later date,

and a discussion of the oil possibilities in this section will be found in Bulletin No. 89.

The following notes record the little activity that has survived the general decline in mining during the past year.

GOLD MINES.

Hess Mine. A new shaft is being sunk about 500 feet east of the old shaft to cut the main vein at the 300-foot level. The old workings are caved and abandoned.

Goose Lake Gold Mining Company. The above company is being organized by Geo. S. Freeborn of San Francisco, to develop property near Willow Ranch in the New Pine Creek district. A 200-foot tunnel was run by local prospectors and farmers several years ago. The new company expects to sink a shaft and develop the prospect into a mine. The geological conditions are said to be similar to those at Oatman, Arizona.

SHASTA COUNTY.

Copper has been the predominant metal produced in Shasta County since 1896. Prior to that year the greatest value was in its gold output. During the period from 1896 to 1919, inclusive, the total production of copper has been 619,430,220 pounds, valued at $100,688,269. During the same period, gold to the value of $22,105,879 was produced. Silver to the amount of $10,167,103, and 29,190,409 pounds of zinc, valued at $3,431,758, were added to the county's production record at the same time. The total value of the four metals, copper, gold, silver and zinc, produced during the above period was $143,509,074. The value of other metals and structural and industrial minerals, if added, would increase this total by several millions.

Production statistics of all classes of mineral products for the years 1917, 1918 and 1919 are given in the following tables:

Commercial production for 1917 was as follows:

Substance	Amount	Value
Chromite	3,116 tons	$68,479
Copper	28,009,990 lbs.	7,646,727
Gold		775,125
Lead	8,725 lbs.	750
Lime and limestone		78,101
Platinum	14 oz.	1,100
Silver		520,703
Stone, miscellaneous		800
Zinc	8,281,516 lbs.	844,715
Other minerals*		308,369
Total value		$10,244,869

*Includes cadmium, brick, iron ore, mineral water, molybdenum, pyrite, and silica.

Commercial production for 1918 was as follows:

Substance	Amount	Value
Chromite	1,423 tons	$70,214
Copper	25,294,590 lbs.	6,247,767
Gold		543,509
Lead	492,565 lbs.	34,972
Limestone	45,671 tons	72,410
Platinum	35 oz.	2,709
Silver		420,410
Stone, miscellaneous		7,000
Zinc	3,045,692 lbs.	277,158
Other minerals*		422,525
Total value		$8,098,671

*Includes cadmium, brick, iron ore, lime, mineral water, molybdenum, and pyrite.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Copper	8,673,342 lbs.	$1,613,242
Gold		525,000
Lime and limestone		29,100
Platinum	121 oz.	21,075
Pyrite	138,046 tons	497,398
Silver		[1]155,000
Stone, miscellaneous		31,750
Other minerals*		40,153
Total value		$2,912,718

*Includes barytes, brick, iron ore, lead, mineral water, and zinc.
[1]Estimated.

The mines and mineral resources of the county are described in the Fourteenth Report of the State Mineralogist (1913-1914), Bulletin No. 50, 'Copper Resources of California,' a revised and enlarged edition of Bulletin No. 23, the first report devoted exclusively to the copper deposits of the state, describes in detail the Shasta copper belt.

No general report on the county has been published since the Fourteenth, but the occurrences of quicksilver are noted in Bulletin No. 78, platinum deposits are described in Bulletin No. 85, manganese and chrome in Bulletin No. 76, and the clay resources in Preliminary Report No. 7, all issued since the Fourteenth Report.

Nearly all field work in the Northern California division during the season of 1920 was devoted to the investigation of petroleum possibilities in this field. Bulletin No. 89 gives the results of this work.

The following notes on the mineral industry, largely obtained through correspondence, are intended to supplement previous reports and bring them up to date by listing properties hitherto not mentioned, noting changes in ownerships and general development during the year.

BARYTES.

Loftus Barytes Mine. Owners, Loftus and Sons, Castella, California. Property is located on Tom Neal Creek, four miles southwest of the railroad station by good trail. Elevation 5000 feet. It is on the forest reserve and plenty of timber and water are available. Assessment work only is being done. D. O. Deuffel, 503 Market street, San Francisco, has an option on the mine.

COAL.

Beegum Creek Deposit. Owners, Don Noble and D. F. Weed, post office, Ono, California. Property is located in sections 31 and 32, T. 29 N., R. 9 W., at an elevation of 2100 feet. Cottonwood, the nearest rail shipping point, is 45 miles east by road. The Red Bluff-Eureka highway runs to Noble's Station. From here there is a three-mile chrome haulage road and 1½ miles of trail to the claims. The surface is hilly and rough. A small perennial stream in Coal Gulch, tributary to Beegum Creek, would probably furnish sufficient water for a boiler. The total area is 320 acres, 200 being in section 32 and 120 in section 31.

The deposit consists of a vein of semi-bituminous coal, overlying serpentine and capped with hard silicified slaty shale. At the cropping the vein is 4″ to 6″ thick. A cross-cut tunnel driven about ten feet below the vein, cut it at forty feet and then followed on the dip to 75 feet from the portal. In the face of this tunnel, the seam is three feet thick, with some traces of lime shale.

Twenty-two feet above the lower seam, another parallel seam outcrops. The latter has not been developed.

The seams strike almost due east and west, dipping 18° S. The outcrops can be traced here for over a half mile and across Beegum Creek for a couple of miles. The coal is hard and said to be excellent blacksmith coal. It has been used locally in the forge. Owners can place it at the railroad for $10 per ton. The long haul to the railroad is the principal hindrance to commercial production.

Dakin Coal Mine. Owners, Dakin Estate of San Francisco. Property consists of patented ground, having an area of 951 acres, situated in section 12, T. 33 N., R. 2 W., in the Little Cow Creek mining district. Bella Vista, the nearest railroad point, is about 12 miles southwest. The deposit lies at an elevation of 1900 feet. There is some pine timber on the property and a spring.

The deposit consists of coal seams separated by thin layers of clay, with a combined thickness of at least fourteen feet. The thickest coal seam exposed is 2½ feet at the widest part, grading down to six inches. The coal is a light, blocky lignite. The clay layers, separating the coal seam, are not over a few inches thick at the most, so that the greater part of the total width is coal. The deposit is overlain by a stratum of sandstone, which is capped by basaltic lava. Clay and shale occur below it. The bedding is almost horizontal. Development work consists of an adit, driven in it for 350 feet. Coal is exposed in the drift, over its full height. No work has been done for about twenty years, but an enormous tonnage could be developed.

COPPER.

Afterthought Copper Company. This company shut down its flotation mill and reverberatory furnace at the Afterthought mine in February and laid off its large crew of men for an indefinite period.

Akers Group. Owners, J. W. Akers and Frank Meixner, Kennett, California. Property consists of 280 acres, comprising fourteen claims, ten located on the north side and four on the south side of Squaw Creek, which here runs nearly east-west. They are situated in sections 6 and 7, T. 33 N., R. 5 W., adjoining the Trinity Copper Company's property, and are on a line between the Mammoth and Balaklala mines. The ground rises steeply from the creek on both sides. There is a good road from Kennett, the nearest railroad point, five miles distant. There are six or seven tunnels on the claims, varying from twenty feet to 350 feet in length. The lowest tunnel has an elevation of 1000 feet and the highest an elevation of 1600 feet. Small veins in fracture planes, along which movement has taken place, carrying iron and copper sulphides, are encountered in a number of the workings, but no definite ore-body of size has been developed. All work has been by hand. Equipped with hand tools and cabin.

Balaklala Consolidated Copper Company. The Balaklala mine has been closed down, during the year. Large ore reserves are blocked out and the company is in a position to produce whenever the Mammoth Smelter resumes operation.

Bully Hill Mines, Incorporated. (See Shasta Zinc and Copper Company.)

Clover Creek Copper Lease. Owners, G. Cleveland Taylor et al., Redding, California; (bond and lease from Central Pacific Railroad Company). Property consists of 240 acres comprising 160 acres of patented railroad land and four claims, located by Taylor in section 32, all in the Clover Creek mining district. There is an auto road to within one mile of the claims. They are situated fifteen miles east of Palo Cedro, a station on the branch railroad from Anderson to Bella

Vista. The elevation is 1500 feet. There is no timber on the property, but it can be obtained, cut, at a saw mill three miles away. Clover Creek contains sufficient water the year round for all purposes.

Country rock is rhyolite (alaskite porphyry). The ore bodies occur in irregular fissures that show extensive shearing. The shear zone is of undetermined width, but is at least several hundred feet wide. It strikes N. 65° W. and dips almost vertical. The alaskite is capped with basalt and is only exposed where the creek has cut a deep channel through the basalt. The cañon is evidently due to a fault as a diorite dike, which is exposed on the west side of the creek, lies, about 300 feet upstream, on the east side. The width of the dike is forty feet. Some small gossan croppings are exposed along the creek bed. Above the water level where cuts have been made, oxides of copper are found, below the water level chalcopyrite occurs. Some iron is associated with it, but no zinc.

Development work consists of a main tunnel driven south 30° west, for 80 feet. At thirty feet from the portal, a drift was run southeast along the ore zone. About 20 feet in the drift, a winze, sunk 9 feet, cut an ore body 7 feet wide, carrying chalcopyrite, the ore averaging 4.37% copper across the face. Beyond the winze, the drift is not in ore. A series of parallel cross slips striking N. 30° W. were encountered in this working and in each case they cut off the ore body. Beyond the drift to the face of the tunnel very little ore is seen. Besides the tunnel, numerous small open cuts have been made along each side of the stream, for ¼ mile in both directions. In all cases where ore is exposed, there is a prominent cropping of alaskite. A cropping heavily stained with copper oxides occurs one-fourth of a mile east of the tunnel. It lies in contact with the diorite dike. The ore-zone here is from 20 to 30 feet wide. The Afterthought Mine is four miles northwest, the power line to the Afterthought passing within one and one-half miles of the property. No work has been done for some time, but the surface indications are good.

Dozier Copper Prospect. Owners, Dr. E. Dozier, J. W. Sandholt and Geo. O'Grady, Redding, California. Property consists of 320 acres of patented land, being the west one half of section 13, T. 33 N., R. 5 W. Kennett, the nearest railroad station, is about one and one-half miles in an air line or four miles by road, that passes within one and one-fourth miles of the croppings. Elevation is from 1500 feet to 1900 feet. There is some pine timber and Moody Creek, which flows all year, contains sufficient water for prospecting purposes. The ground is hilly, the deposit being near the summit of a spur ridge from Bass Mountain. The prospect was discovered several years ago and a few tunnels and cuts were driven. It was acquired by the present owners in 1918.

The deposit is marked by large gossan croppings near the summit of the ridge in black shales and cherts of the Kennett formation near a contact with rhyolite. The extent of the rhyolite has not been determined, but it appears to be a dike striking almost due south with the trend of the ridge.

There is a tunnel driven 120 feet vertically below the most prominent cropping, into the Kennett formation, a few feet from the dike. The face of the tunnel at about 170 feet from the portal is in rhyolite,

with which is associated masses of gossan and large cubes of iron pyrite. For the first 30 feet in the Kennett formation, exudations of copper sulphate are seen on the walls and the water is stained with it. The gossan appears to be dipping about 40° southwest. On the surface it covers an area approximately 200 feet by thirty feet. No copper indications are found in the other small cuts or tunnels. The surface indications warrant prospecting with a diamond drill.

Greenhorn Mine (formerly **Warren Brothers Mine**). Owners, Atascadero Mining Company, 1014 Hobart Building, San Francisco, California; C. E. Gilman, secretary; Albert Hanford, superintendent of mine, post office, Tower House. Property is located in the French Gulch mining district in section 6, T. 32 N., R. 7 W. Redding, the nearest railroad point, is 22 miles southeast. The Redding-Weaverville lateral of the state highway passes the mine. The camp is on Willow Creek, at an elevation of 2000 feet and has an excellent water supply. There are fifteen unpatented claims and 120 acres of patented land in the holdings which have a total area of 420 acres. The country rock is quartz porphyry (altered ryholite). The deposit consists of lenticular ore-bodies in a sheer zone in the altered rhyolite. These lenses dip 20° to 30° westward, raking to the north. The ore is mainly chalcopyrite or pyrrhotite with some cuprite in the upper workings, as well as malachite and azurite. The largest ore-bodies are, however, mostly chalcopyrite in a gangue of pyrrhotite and pyrite. As the rhyolite is very much fractured, timbering is necessary throughout the workings. The ore-bodies vary from thin seams to ten feet in thickness. They are usually cut off by fault planes in the rhyolite.

Development work consists of six tunnels and several thousand feet of drifts, raises, etc. No. 1 tunnel, the lowest working, is at an elevation of 1833 feet, the portal being 100 feet above Willow Creek. It is driven due east 450 feet where it cut black slate. A raise of 90 feet from the north drift cut a face of high grade ore six feet thick. Several thousand feet of drifts, from No. 2 tunnel, 90 feet above No. 1, expose numerous ore bodies. This tunnel cuts the slate at 550 feet. No. 3 tunnel was driven due east 350 feet from which point a drift was run south for 350 feet. From this level considerable ore was shipped by former lessees. A new tunnel, No. 4, at an elevation of 2095 feet, is in an iron gossan for 100 feet. No. 5 tunnel, at an elevation of 2207 feet, is an original working from which considerable ore was shipped. Tunnel No. 6, at an elevation of 1867 feet, was driven 1000 feet eastward below No. 5, but failed to cut an ore body.

The mine is equipped with a compressor plant at No. 2 tunnel, containing an Ingersoll-Rand 10″ x 12″ compressor, operated by electric power. There are also air drills and blacksmith shop, boarding house, bunk house, etc. The erection of an acid-leaching plant is contemplated. The mine was discovered in 1901 and worked from 1910 to 1916, ore being shipped to the Mammoth Smelter. The present company took over the property in January, 1919. The management estimates that there is 260,000 tons of 3.2% copper ore blocked out and 450,000 tons of probable ore. Idle during the past year.

Shasta Zinc and Copper Company (formerly **Bully Hill Mines, Inc.**) The famous group of mines at Bully Hill, known as the Bully Hill Mines, Incorporated, were sold during the year to the Shasta Zinc and Copper Company, home office, Hobart Building, San Francisco, California; W. Arnstein, president; D. C. Jackling, managing director; R. L. Beals, superintendent; post office, Winthrop, California. The new company is capitalized at 200,000 shares of no stated par value. Of this amount, D. C. Jackling, in conjunction with Hayden Stone and Company have taken one-half and one-half has been retained by W. Arnstein et al. The new company also acquires the Sacramento Valley and Eastern Railroad, a broad gauge line connecting the mines at Bully Hill with the main line of the Southern Pacific at Pitt, a station three miles north of Kennett.

Development work has been carried on at their Rising Star Mine for the past two years and approximately 300,000 tons of ore are now blocked out. Thirty to forty men are employed in the mine. The erection of a new treatment plan for the production of copper matte and zinc-oxide is progressing rapidly. Much of the structural steel used is being obtained from the old Balaklala smelter at Coram, which is being torn down and the material shipped to Bully Hill, so that rapid progress is being made. One hundred and twenty-five men are employed on construction and the new plant is expected to be ready for operation by March, 1921. The general layout includes mechanical roasters, storage bins, cooling system, reverberatory furnaces and baghouse. For the present the 150-ton flotation plant will not be used.

GOLD—QUARTZ MINES.

Alice Mines (formerly **Alice Consolidated Mine**). Owners, J. E. Baker, Mrs. E. Bui and L. Neivi; incorporated as the Crescent Copper Company; J. E. Baker, president, 222 Market street, San Francisco, or Redding, California.

Property is located in the Shasta mining district in section 19, T. 32 N., R. 5 W., about 1½ miles west of Keswick, the nearest railroad point. The holdings include the Alice Consolidated group and the Zeb, Monarch, October and Peacock claims, the total area being about 170 acres. The mine has an elevation of 600 feet. Water is obtained from Rock Creek. The deposit was discovered about thirty years ago but was relocated and incorporated in 1918.

Deposit consists of several veins, some small and some of fair size. The ore is base. Development work consists of three tunnels, 300, 80 and 25 feet long, the greatest depth reached on the veins being 60 feet. A power line crosses the property. It was a small producer at one time.

Arndt-Haschke Mine. Owners, Geo. C. Arndt and E. W. Haschke, post office, Ingot, California. Property consists of four claims, having an area of 80 acres, situated in sections 33 and 34, T. 34 N., R. 2 W., in the North Cow Creek district. Ingot is the nearest town and Redding, 24 miles southwesterly the nearest railroad point. The elevation is 1200 feet and there is some timber on the claims. Country rock consists of porphyry, phonolite and slate. There is a gossan carrying some gold. The owners are driving a tunnel for development purposes.

Black Bear. Owners, Strayer Brothers, Oak Run, California. Property located in T. 33 N., R. 2 W., in the Cow Creek mining district.

Black Cloud and Red Top (formerly **Reservoir and Offset Mine**). Owner, James Duffy, care S. A. Meek, Quartz Hill, or Redding, California. Property consists of one claim and a fraction, with a total area of about thirty acres. The claims are in section 15, T. 32 N., R. 5 W., 4½ miles north of Redding and 2½ miles from Keswick in the Quartz Hill mining district. There is no water except in the winter. Quartz veins outcrop on the surface and two of these are cut in the main shaft. The principal vein is four to six feet wide. The shaft is down 165 feet and there is a 60 foot drift and forty-five foot crosscut on the 100-foot level. The ore is said to be of good milling grade and amenable to cyanide treatment. A shipment to the former smelter at Coram, of 100 tons obtained in shaft sinking, gave returns of $3.00 per ton. There is no equipment.

Evening Star Claim. Owner, C. C. McCray, French Gulch, California. Property consists of one full claim adjoining the Washington and Milkmaid mines in the French Gulch district. Located over twenty years ago and assessment work kept up. The owner states that total values received from milling ore would about pay for assessment work. Under lease and bond until July 1, 1921.

Florida Group. Owner, T. E. Graff, Redding, California. Property consists of the West Point, Golden Jubilee, Florida, Daylight, Miner's Dream, Irma B., Big Gem, Last Chance, Lost Hope, White Elk, Northern Light and Keith claims, having a total area of 240 acres. The holding is located in the Middletown mining district, in sections 7, 12 and 18, T. 31 N., R. 5 W., 7 miles west of Redding. There is a good auto road to the property. Elevation 1000 feet. Olney Creek furnishes water during eight or nine months of the year and water has been encountered in sinking shafts. The surface ranges from low rolling hills on the southeast to mountainous on the northwest. This is one of the early placer mining districts and the claims were located years ago, but very little work has been done on the main ledges. The country rock is meta-andesite and the deposit consists of quartz veins on the contact of the meta-andesite and slate, or more commonly in the meta-andesite. There are two principal quartz ledges and a series of smaller ones. They are very regular with well defined walls. The quartz filling is considerably shattered and iron stained in the fractures. Oxide of copper was found in one place. The gold occurs both free and in sulphides.

The Miner's Dream ledge located about midway of the group is very strong and can be traced by its extensive outcrops almost the entire length of the claim. The strike is N. 80° E., with dip to the north. Several shafts have been sunk to a depth of from 40 to 50 feet. From a tunnel driven about 100 feet a winze was sunk 50 feet and here the vein was 12 feet wide. Croppings are from three to ten feet wide. In one cut a sample of ore ran 24.65% copper. Assays along this ledge are said to have run $16.60, $25.40, $12 and $8.10. The Big Gem ledge, apparently the strongest and most persistent of the group, lies south of the Miner's Dream. It strikes N. 30° W., the outcrop varying from five feet to fifteen feet in width and extending the length

of the claim and beyond its southeasterly limit. It has been developed only by means of shallow shafts, the deepest being seventy feet. None of the workings are sufficient to determine its value and it is worthy of further development.

The Irma B. lies south of the Miner's Dream and strikes north-south. The principal working here is a forty foot shaft. This was sunk on a stringer that was expected to yield a pocket. At the bottom of the shaft a strong vein is exposed which pans free gold. An 1148 lb. shipment to the Mountain Copper Company, of an assay value of $49 per ton, gave returns of $26.98 and another of 2561 lbs., to the Selby Smelting and Lead Company, assay value $38.60, returned $48.43.

Besides the above described claims, the others all have well defined quartz ledges of like appearance, the most notable being the Last Chance. A ton of ore taken from the surface here a few years ago and shipped to the Keswick smelter yielded $43. There is very little equipment on the property and no maps or notes. The latter, and all reports having been destroyed in the San Francisco fire. A small amount of development work is being done.

Gladys Mine. Owners, E. E. Hart and Donald McPhail, Shasta, California. Property consists of the Gladys and Jay Bird claims and the Monzel group of four claims, having a total area of 120 acres. The mine is located in section 34, T. 32 N., R. 6 W., in the Shasta mining district and is ten miles northwest of Redding, the nearest railroad point. It is four miles from the highway by wagon road, with some heavy grades, but it is possible to drive within one-fourth of a mile of the camp. The elevation at the tunnel is 1500 feet. There is some yellow pine on the property and two springs, good for camp use. The claims were located in 1899 and have been worked only by the owners.

The country rock is quartz porphyry and the deposit consists of parallel quartz veins, cutting it, the two principal veins being about 75 feet apart. The veins are hard white quartz, well defined with a gouge on the footwall side. The vein matter is heavily stained with iron and manganese and the ore is base, the gold occurring mostly in sulphides. The walls are hard and no timbering is necessary. The main vein averages four feet in width, with a maximum width of six feet. It strikes N. 55° E., and dips 85° northwest.

A crosscut tunnel driven N. 70° W. cut the main vein at 300 feet. Here it is split and broken by a fault striking N. 65° E. Drifts run to the south cut a vein at 75 feet and to the north at about 50 feet, but they are caved. A shaft sunk on an outcrop caught this drift at 130 feet depth. It is caved near the bottom. The second vein is not cut by the tunnel. A shaft sunk 75 feet on the second vein shows it to be two to three feet wide. At 150 feet in, the tunnel cut a two foot vein reported to assay $6 per ton. All work is by hand drilling, the only equipment being a blacksmith shop and cabin. Owners would like to lease or sell.

Gold Leaf (formerly **Crown Deep**). Owners, Ira Judson Coe, et al., Mills Building, San Francisco. Property consists of four claims, the Gold Leaf, Gold Bronz, Summit and North End, located in section 5, T. 31 N., R. 5 W., in Lower Springs mining district. Redding, the

nearest railroad point, is four miles east, one mile by county road and three miles by highway. Elevation 500 feet; water is obtained from springs. The country rock is andesite and black slate and the deposit consists of quartz veins carying gold in sulphides. Maximum width of the four veins is twelve feet, averaging six feet on the East Gold Leaf and two feet on West Gold Leaf. The strike is northeast and dip 65°. The length of the pay shoot is 110 feet and its average width six feet. The shaft is down 400 feet, cutting the vein 430 feet below the outcrop. A drift has been run 175 feet on the vein from the bottom of the shaft and 150 feet drifted on each of the five levels. Equipped with electric hoist. Power is obtained from the Pacific Gas and Electric Company. Idle since 1916.

Happy Jack and **Mountain Monarch Group**. Owner, Charles L. Paige, box 195, Santa Barbara, or Redding, California. The Happy Jack Group consists of the Happy Jack, Nonpareil, Langtry, Mountain Belle, Mountain View and Knickerbocker patented locations and the unpatented Illinois, Peoria and Greenstone locations. The Mountain Monarch Group comprises the Great Slide, Boulder and Nos. 1 to 17 locations, the total area being about 560 acres. The property is in the Whiskeytown (Stella) mining district in sections 28, 32 and 33, T. 31 and 32 N., R. 6 W. Shasta is the nearest town. Redding, the nearest railroad point, is ten miles east. From the state highway, which passes within three or four miles, a fair wagon road extends to the property. The elevation ranges from 3000 to 5000 feet and timber is plentiful. Water can be obtained from Clear Creek, Brandy and Boulder creeks. The surface is steep, with deep ravines and gulches.

Country rock is a schistose diabase, with granite to the west. White quartz veins occur, carrying both free and base gold ores. The Happy Jack is the principal gold vein. Numerous cross and secondary veins also occur. The Happy Jack varies from three feet to eight feet in width, averaging about four feet, and strikes northwest-southeast, with dip nearly vertical. There are no deep workings and many of the shallow shafts are caved. They are chiefly on the smaller cross veins and near the surface, where pocket and free milling deposits were worked by bucket and windlass.

On the Mountain Monarch group, located for copper, there is an 850-foot tunnel, which should tap the main vein about 650 feet below its outcrop, if extended some 75 feet.

Good water power is available within one mile, but it was never used except to run an arrastra and old cannon-ball mill. All buildings, etc., have been destroyed by fire. The property is favorably situated and easily accessible from the highway.

Jumbo Prospect. Owners, W. W. Felt and J. Smith, Redding, California. Property consists of 40 acres of patented land in section 18, T. 31 N., R. 5 W., near Centerville and 6 miles southwest of Redding, the nearest railroad point. Elevation 900 feet. Water can be obtained from Olney Creek during seven to nine months of the year.

The country rock is meta-andesite and the deposit a quartz porphyry dike carrying auriferous quartz veins. It was worked years ago as a placer. A series of parallel shoots strike east-west and dip 30° to 40° south. They are bunchy, but appear to be persistent. All work has

been entirely superficial. The deepest working is a shaft sunk fifty feet on a quartz vein in which there is said to be a 75-foot drift at the bottom. It is caved and full of water. Numerous pits and trenches expose quartz veins from one to one and one-half feet wide. The rock is soft and decomposed on the surface. Gold can be panned from any of the dumps.

Minneshasta Mine (formerly **Brackett Mine**). Owners, Wm. Miller, G. B. Crabtree, T. R. Thompson and Isadore Krauss. Incorporated as the Minneshasta Mining Company, 512 Lumber Exchange, Minneapolis, Minnesota; Wm. Miller, president; Isadore Krauss, superintendent, Shasta, California. Property consists of four claims, the Mt. Pleasant, Center Slope, Rough and Ready and Brackett Fraction, situated in section 33, T. 32 N., R. 5 W., in the Shasta mining district. It contains eighty acres and is located four miles west of Redding on good road. Water is obtained from the mine. The mine was discovered in 1890. It was closed during the war, but work was resumed late in 1920. The deposit consists of a quartz vein averaging six to seven feet in width, carrying base gold ore. The strike is north-south and the vein stands nearly vertical. It has been proven on the surface for 3000 feet. The greatest depth developed is 300 feet. There are two tunnel levels. The lower tunnel is in 1800 feet and the upper tunnel 700 feet. There is still another tunnel, fifty feet higher, 110 feet in length. The vein has been drifted on for 250 feet. All work has been by hand, the only equipment being track, cars, tools and blacksmith shop. Ore produced has been shipped to smelter.

North Star. Owner, Geo. W. Garwood, French Gulch, California. Property consists of the North Star and Virginia claims, a total area of forty acres, located in section 9, T. 33 N., R. 7 W., in the French Gulch mining district. Originally located in the early sixties, they were relocated by the present owner in 1902. Deposits consist of one main quartz vein, with feeders from the footwall. The country rock is porphyry and slate. The average width of the vein is eight inches and the values are spotted. It strikes north-south and dips 80° east. Development work consists of a 300-foot tunnel, 300-foot drift and 60 feet of crosscuts, winzes, etc. The vein is an extension of that in the Milkmaid, an adjoining mine. Equipment consists of shop and tools.

North Star. Owner, C. P. Baker, Schilling post office, California. Prospect located in Whiskeytown mining district, in section 6, T. 32 N., R. 6 W.

Rawhide Mine. Owner, A. C. Renfrew, Shasta, California. Property consists of one claim of 20 acres in section 19, T. 32 N., R. 5 W. It is on old road two and one-half miles from Keswick, the nearest railroad point. The country is rugged and broken. Water can be obtained from Rock Creek. The deposit consists of a quartz ledge about two and one-half feet wide, which pans free gold. Discovered in 1920. No development.

W. and W. Prospect. Owners, H. D. Willard and J. J. Williams, Shasta, California. Property consists of two claims, the East Half and West Half, a total area of forty acres, located in the northwest quarter of section 19, T. 32 N., R. 5 W., about 1 mile west of Keswick,

the nearest railroad point. There is a rough mountain road to the mine. The claims have an elevation of 1500 feet and the ground is hilly and rugged. There are three springs, said to flow all the year. The country rock is meta-andesite. Auriferous quartz veins form the deposit. There is one principal vein and several smaller parallel veins. They are well defined. Quartz highly oxidized on the surface. The ore is said to be free milling, but it contains sulphides. Chalcopyrite shows in the shaft. At the outcrop, the principal vein is from six inches to one foot in width, widening to three or four feet in the bottom of the shaft.

The strike is N. 70° E. and dip 65° N. It has been proven on the surface for 150 feet. A shaft, down fifteen feet, is being deepened and there is a fifty-foot open cut along the vein.. No equipment except a few tools. Located in 1919.

Yankee John Mine. Owners, Yankee John Development Company, W. L. Clark, president; home office, Pittsburg, Pennsylvania; R. T. Peirce, superintendent, Redding, California. The mine is 6 miles southwest of Redding, the main county road from Redding to Ono passing within one-half mile. The country consists of low rolling hills; elevation at the mine 930 feet. Water is obtained from Olney Creek during the winter and stored in a reservoir covering eighteen acres. It is ample for milling purposes throughout the year. The holding consists of five mineral claims and 305 acres of patented lands on which the reservoir is located, a total area of 400 acres. The mine was worked about thirty years ago by an old company. The present company began operations in 1915.

Country rock is meta-andesite and the deposit consists of a series of parallel quartz veins in the meta-andesite and slate. They are well defined and hard. The quartz carries some free gold, but gold also occurs in the pyrite, necessitating concentration.

The general trend of the veins is east-west, the dip being almost vertical. The vein under development is from one to four feet in width, averaging about two and one-half feet. It is faulted and bunchy. The largest ore-shoot encountered was 175 feet. There is a vertical shaft, 300 feet in depth, with levels at 70, 100, 200 and 300 feet, but all workings below the 100-foot level are now inaccessible. There is a stope in a high grade ore-shoot between the 70-foot level and the surface. The vein here is one to four feet wide and is rich in sulphides, there being some galena. The old workings are said to be extensive.

Mining is done with machine drills, including stopers and jackhammers. Equipment consists of 25-h.p., 2-cycle, 2-cylinder Victor gas engine, for new 1000-foot hoist. Fairbanks-Morse engine. Small compressor, pumps, etc. Distillate is used for fuel. Reduction equipment consists of a 12-stamp mill, containing jaw crusher, ten 1000-lb. and two 800-lb. stamps, three amalgamating plates, and one Deister concentrator. It is operated by a 40-h.p., 2-cycle, 2-cylinder gas engine. Tailings are stored for future treatment. Five men were employed in the mine and mill until it was shut down indefinitely in September, 1920, on account of excessive costs. When last operating, the mill was only running one shift and treated about twelve tons per eight hours. Concentrates run about $160 per ton. They were shipped to the Selby Smelter.

GOLD—PLACER.

Grubstake Placer Mine. Owners, Nelson Brothers, La Moine, California. Property is in section 22, T. 36 N., R. 5 W., in the Slate Creek mining district, 1 mile south from La Moine. It is in the Shasta National Forest and contains a small amount of oak, pine and fir. Elevation 1260 feet. The claim was located in 1917 and contains eighty acres. Country rock is slate. Deposit consists of sloping gravel bars. The gravel channel being worked courses north-south, the gravel varying from one to forty-six feet in depth. There is no cement, but boulders up to four tons are encountered. The slate bed-rock is full of holes and crevices. Width of pay gravel about 40 feet and depth 30 inches. The portion of the claims being worked is located on a high bluff about forty feet above the present river level. Here the gravel is about nine feet deep. The top dirt is moved to one side and the pay dirt moved out and dumped into a chute and run down to the river level, where it is washed in sluice boxes. Only worked in the winter on account of scarcity of labor and high wages.

Rainbow Mine. Owner, G. A. Lintow, La Moine, California. Property comprises 28 acres, lying at an elevation of 1250 feet in section 15, T. 36 N., R. 5 W. It is in the Slate Creek District, one mile north of the railroad station and between the railroad and state highway. It was worked in 1861 by J. Keeting and in 1880 by L. Curber. Deposit consists of placer gravel.

Hornet Mine. Owners, Mountain Copper Company, home office, London, England; Sir Chas. Fielding, president; Wm. F. Kett, general manager, and M. J. Murphy, general superintendent, Keswick, California.

The Hornet mine is one of the properties of the Mountain Copper Company. It is located in the Iron Mountain district in section 35, T. 33 N., R. 6 W., and is connected by the Iron Mountain Railroad, owned by the company, with the Southern Pacific main line at Keswick. It lies at an elevation of 2400 feet on the hilly northwest slope above Boulder Creek. The country rock is rhyolite, and the deposit fills a large fissure, due to shearing and crushing of the rhyolite. The lenticular ore bodies are several hundred feet long and of undetermined width and depth. The filling is nearly pure iron pyrite, with not over 1% to 2% of silica and averages 0.7% copper. The strike of the ore zone is N. 30° E., dip almost vertical, with a rake at a high angle to the northeast.

A main adit, 3000 feet in length, has been driven 180 feet vertically below the old adit, formerly used as a haulage way, to cut the ore body. A stope has been opened between the two levels and the ore is mined by combination shrinkage and caving. There is no timbering in the mine. Pillars are left in the stope and later recovered. It is worked in sections of 150 feet along the ore body, grizzlies being placed every 25 feet, to which the ore is broken. These grizzlies are on the mill floor, 25 feet above the adit and 25 feet below the stoping floor. Blasting is done by electricity and from 50,000 to 150,000 tons are broken at one time. The stopes are 150 feet long, 80 to 100 feet wide and five feet high. The broken ore averages 45% sulphur and 0.7% copper.

Electric power is used throughout. No muckers are required. Mine equipment consists of Ingersoll-Rand compressor, machine drills and drill sharpeners, machine shop, etc. Electric haulage is used, ten 7-ton cars being sent to the mill at one time.

The mill consists of 1000-ton crushing and sizing plant, equipped with No. 6 gyratory crusher, conveyor belts, trommels and four Hartz jigs. Three sizes are produced, 1½″ to 4″, sold to the Standard Oil Company ⅜″ to 1½″, and tailings from the ⅜″ sold to the General Chemical Company. About 90% of the pyrite averages 45% sulphur or better. Second-class ore is sent to the Hartz jigs, and the waste is discarded.

The Standard Oil Company returns the pyrite cinder to the Martinez plant of the company, where it is leached and the copper extracted. With the exception of that obtained by the precipitation of mine water and recovered by leaching the pyrite cinder, no copper is being produced by the Mountain Copper Company. Operations at the Iron Mountain mine will not be resumed until market conditions improve. About 150 men are employed at the Hornet mine and mill.

SILVER.

Big Dyke Mine. Owners, Bill Dyke, John and Frank Richter, of Igo, California. The Igo Consolidated Mining Company, Geo. T. Ruddock, president, 729 Mills Building, San Francisco, California, is developing it under bond and lease.

This property, consisting of a group of seven claims, with a total area of 140 acres, is located in sections 17 and 18, T. 31 N., R. 6 W., in the South Fork mining district. It is eighteen miles southwest of Redding, the nearest railroad point. The road is good from Redding to Igo, but the three or four miles from Igo to the mine is rough and has heavy grades. It could be improved at little cost. The mine is located on the rather steep slopes near the top of the ridge, above the Silver Falls mine tunnel, the elevation at the shaft being 2000 feet. There is considerable pine on the property. Water is obtained in a tunnel for camp purposes.

The deposit was discovered years ago. Dyke and Richter Brothers acquired it in 1906, and a little work was done in 1917 and 1918. The present company took it up in December, 1919. Practically all work is confined to the Big Dyke claim.

The country rock is a granodiorite in which the deposit occurs as a quartz fissure vein. The principal vein, the Big Dyke, strikes N. 60° E., and dips almost vertically. It is well defined with strong wall and little timbering is required. The vein matter is from two feet to five feet in width, the best ore being found along both walls in streaks from 4″ to 7 feet in width. The ore contains argentite, native silver, some freibergite, a variety of tetrahedrite, or gray copper ore, containing from 3% to 30% of silver, sphalerite, galena and arsenopyrite. Some gold is associated with the pyrite.

A shaft sunk on the vein has reached a depth of 153 feet. A crosscut has also been driven to the vein, cutting it about 100 feet below the collar of the shaft. Some stoping was done here a couple of years ago and a resulting shipment to the Kennett smelter averaged 300 ounces of silver per ton. It was only stoped about 20 feet above the

main level and for a short distance. The mine is equipped with a gas engine for hoist and compressor, and two air drills. The machinery was used by former operators. The hoist is good for about 400 feet and the compressor is 25-h.p. All ore and waste has been taken out through the shaft. Six men are employed. In March the shaft had been sunk to the 200-foot level and drifting east and west had commenced. Considerable native silver occurs with the sulphides in the ore, giving it a very high grade appearance.

Silver Falls and Chicago Consolidated Silver Mine. Owner, F. M. Archer, Redding, California. This property includes the Pillchuck, Union, Cold Springs, Richmond, Madison and Chicago, patented claims, ten unpatented claims and adjoining patented ground, the total area of the holdings being 340 acres. It is located in sections 17, 18, 19 and 20, T. 31 N., R. 6 W., in the South Fork mining district, and is 2½ miles northwest of Igo. Girvan is 12 miles and Redding about 15 miles distant by good roads. Both are railroad shipping points. The elevation ranges from 1400 feet to 2300 feet. There is some pine and oak on the property. Water is obtained from Andrews Creek. The ledge on the Chicago claim was discovered in 1865 and worked at intervals until the late 90s. The greatest depth attained was 210 feet. It is said to have been rich, and during the early operations ore was shipped to Swansea, Wales, for reduction. The total production of the Chicago is reported to have been approximately $1,000,000. All the old workings are now caved and abandoned.

Country rock is a granodiorite or granite and the deposit consists of a series of fissure veins and seams, carrying tetrahedrite, running high in silver, pyrite and some galena, sphalerite and chalcopyrite. Very little timbering is required.

In 1900 a long cross-cut drainage tunnel was started and run in 3000 feet, cross-cutting the vein system and reaching a maximum depth of 600 feet at the face. Some 36 separate veins and fissures have been cut, but it is believed that the main Chicago lode has not as yet been reached in the tunnel.

The best showing is in the vicinity of veins Nos. 27 and 28, which are presumed to represent the Madison lode on the tunnel level. In vein No. 28 two shoots are exposed containing high grade galena ore. From a short drift at this point 40 tons were shipped to Kennett that assayed $.83 gold and 17.7 oz. silver per ton. According to a report by Geo. J. Bancroft of Denver, assays on vein No. 28 were as follows:

	Au.	Ag.
East breast, one foot wide	trace	6.02 oz.
12 feet west of breast, one foot wide	3.08	12.00 oz.
30 feet west of breast, 8 inches wide	3.75	27.00 oz.
106 feet west of breast, 9 inches wide	4.50	75.00 oz.
Solid galena from stope, 9 inches wide	17.00	270.00 oz.
Ore bin sample	2.00	37.00 oz.

Cyaniding and concentration tests made on the ore by Smith, Emery and Company indicate that a total recovery of 90% of the gold and 66% of the silver is possible without roasting. Preliminary flotation tests are said to indicate a recovery of 95% of the silver content.

The mine equipment used at the time the long tunnel was driven was destroyed by fire in 1912. The present owner has installed track and

cars and 3000 feet of ten-inch air-pipe and blower driven by gasoline engine to ventilate the mine. There is an electric power line within two miles. Three men are employed advancing the tunnel face. Equipped with blacksmith shop and camp buildings.

Silver King Mine. Owners: Under lease to L. C. Parker, et al., Redding, California. Property is located in the Middletown mining district in section 8, T. 31 N., R. 5 W. Redding, the nearest railroad point, is four miles east by good road. There is one claim, the Silver King, located about thirty years ago. The surface is rolling hills, having an elevation of 800 feet at the shaft. There is some digger pine and oak on the claim. Water is obtained from the mine, and for domestic purposes from a spring.

Country rock is meta-andesite, which is cut here by an intrusive alaskite-porphyry dike. The deposit consists of a more or less brecciated quartz vein, carrying copper and silver, which follows the contact of the alaskite and meta-andesite on the footwall side of the intrusive. The dike is about sixty-five feet wide and the vein averages two feet in width with a maximum thickness of eight feet. The ore-body strikes north-south and dips 82° east. It has been proven on the surface for the full length of the claim. The vein is well defined with hard walls and little timbering is required. The ore is a siliceous copper sulphide, carrying high silver values, the principal minerals being chalcopyrite, chalcocite, and argentite. The pay-shoot was 150 feet long and fourteen inches wide.

Development work consists of a 325-foot vertical shaft with four levels. No. 1 at 90 feet, No. 2 at 150 feet, No. 3 at 200 feet and No. 4 at 300 feet. Level No. 1 is drifted on for 80 feet; No. 2 for 320 feet; No. 3 for 160 feet, and No. 4 for 410 feet. At the 300-foot level a cross-cut was run 90 feet west, to and through the hanging wall of the dike. There are three raises above the 150-foot level and the vein has been stoped approximately 40′ x 2′ x 80′ and about 1000 tons of good grade ore shipped to the smelter. Ore reserves are estimated at 500 tons partly developed. Hand and machine drills are used.

The mine is equipped with a good shaft house, 40-h.p. steam boiler and 15-h.p. Vulcan hoist with 500 feet of $\frac{3}{4}$″ cable; also a 40-h.p. Deisel hot-head engine, a 9″ x 8″ Sullivan compressor, and pumps, cars, blacksmith shop and all necessary tools for mining. When operated from twelve to eighteen men were employed. A good boarding house, foreman's house, and bunk house provide accommodations. It was shut down in 1918 and has been idle the past two years.

SISKIYOU COUNTY.

The inaccessibility of the mineral-bearing sections of Siskiyou County has hindered the development and equipment of its lode mines and many of the hydraulic and placer properties have a comparatively short season's run, even in years of average precipitation, on account of the necessity of bringing water long distances, if an adequate supply is to be obtained.

Due to high production costs and the unusual dry season, there has been very little activity in precious metal mining in 1920.

The Davis Consolidated Mine at Happy Camp has been kept in operation despite adverse conditions. This property has become, since the closing down of the La Grange Mine in Trinity County, the largest hydraulic mine in the state. Two important copper districts have been developed, one near Happy Camp, where the Gray Eagle Mine is located, and one at Copper in the western part, near the Oregon line, where the Blue Ledge mine is producing.

The mines and mineral deposits of the county are described in the Fourteenth Report of the State Mineralogist. Manganese and chrome mines have since been reported on in Bulletin No. 76, quicksilver properties in Bulletin No. 78 and the clay deposits in Preliminary Report No. 7.

The mineral resources of the county include baryte, chromite, clay, coal, copper, gems, gold, graphite, lead, limestone, manganese, marble, mineral water, potash, pumice, quicksilver, sandstone, silver and miscellaneous stone. Siskiyou is the fifth county in California in size and offers splendid opportunity for future development of its mineral resources.

Commercial production for 1917 was as follows:

Substance	Amount	Value
Chromite	2,046 tons	$49,797
Copper	888,043 lbs.	242,436
Gold		325,550
Granite		500
Lead	192 lbs.	17
Mineral water	503,000 gals.	50,600
Platinum	15 oz.	709
Silver		16,883
Stone, miscellaneous		134,382
Other minerals[1]		8,535
Total value		$829,409

[1]Includes lime, sandstone, and soda.

Commercial production for 1918 was as follows:

Substance	Amount	Value
Chromite	6,612 tons	$336,588
Copper	573,593 lbs.	141,677
Gold		294,227
Mineral water	501,750 gals.	50,175
Platinum	1 oz.	58
Silver		14,501
Stone, miscellaneous		24,588
Other minerals[1]		15,473
Total value		$877,287

[1]Includes lead and pumice.

Commercial production for 1919 was as follows:

Substance	Amount	Value
Chromite	510 tons	$13,379
Gold		350,000
Mineral water	451,500 gals.	90,375
Platinum	7 oz.	1,015
Silver		[2]16,000
Stone, miscellaneous		26,405
Other minerals[3]		111,294
Total value		$608,468

[2]Estimated.
[3]Includes copper, limestone, pumice, and quicksilver.

Field work during the year was limited to that done in connection with Bulletin No. 89, and the following notes on the metal mines, which are intended to supplement previous reports, have been obtained principally through correspondence. They cover, as far as possible, properties not previously of record and such changes and developments as have taken place at the mines heretofore reported on.

CHROME.

Mountain Chrome No. 1 and No. 2.—Owner, W. D. Dale, Sacramento, California. This property was discovered in 1918. It is located in section 24, T. 41 N., R. 6 W., in Edgewood Mining district, the railroad station of Edgewood being seven miles northeasterly. The prospect is situated at an elevation of 2500 feet along the North Fork of Shasta River. An open cut fifteen feet wide has crosscut eighty feet of chrome ore. One man only has been working.

Blue Ledge Mine. Owners, Mexican Smelting and Refining Company, 82 Beaver street, New York City; Geo. Foster Peabody, president; R. E. Safford, secretary; D. C. Brown, general manager, 82 Beaver street, New York; Jerome A. Hilbert, superintendent, post office, Copper, California. Jacksonville, Oregon, 33 miles northeast is the nearest town. The mine is in township 48 N., R. 11 W., and on the Crater Lake National Forest. There is a good wagon road from Jacksonville to the property. The country is precipitous and covered with abundant pine and fir. The elevation is 5000 feet. Water is obtained from tributaries of Applegate River.

The Blue Ledge mine was discovered in 1898. From June, 1909, to October, 1916, it was closed down.

The property consists of 26 patented mining claims, having a total area of 486.9 acres. The country rock is schist and the deposit consists of lenticular veins, carrying primary copper sulphides, gold and silver. The ore is base, as is shown by the following analysis of a composite sample:

Ag.	2.68 oz. per ton	SiO_2	10.0 %
Au	.08 oz. per ton	Al	14.18%
Cu	4.85%	Ni	0.0 %
Fe	32.399%	Co	0.0 %
Mn	18.64%	S	35.00%
CaO	0.0 %		

A dark schist forms the footwall of the main Blue Ledge vein and the hanging wall is a lighter colored schist. The vein strikes north-south and dips 60° west. It has a maximum width of 35 feet, but averages about 5 feet. It has been proven on the surface for 23,000 feet. The length and average width of the pay-shoot developed is 1500 feet by 5 feet. Greatest depth reached below outcrop 600 feet; length driven on the vein 1800 feet. There are four main tunnel adits, the total length of tunnels and drifts approximating 9000 feet. Crosscuts, raises and winzes total 6000 feet. There are various small stopes, their maximum height being 75 feet, length 150 feet and maximum width 35 feet.

It was estimated by the management that there are 240,000 tons of ore blocked out, having an average content of 4.8% Cu., Au. .035 oz., Ag. 1.5 oz., per ton. Over hand stoping methods with open and cribbed chutes are used.

Steam is used for power. Wood for fuel is cut on the claims and costs $7 per cord. The mine is equipped with a 500-cu. ft. 2-stage Sullivan air compressor, jackhammer stopers, underground hoist and a 1500 foot aerial tram. There is no reduction equipment. Twenty-five men are employed, thirteen on top and twelve in the mine. Development costs are given as $5.85 per ton; mining $11.95 per ton; general, $7.55 per ton. Total operating cost $37.43 per ton. Power costs $2.57 per ton, labor $12.06, timber 10c per ton and transportation $10.50. Production to date, 8460 dry tons. Ore was shipped to Tacoma Smelter and gave an average assay of Cu. 13.7%, Ag. 5.5 oz., Au. .1 oz., Fe 30%, S. 30%.

Gray Eagle Mines (formerly **Dakin Mine**). Owner, Mason Valley Mines Company of Nevada; operating company, Gray Eagle Mines Company, Wm. Kermer, superintendent, Happy Camp, California.

This property is in section 4, T. 17 N., R. 6 E., 80 miles by road west of Hornbrook, the nearest railroad point. There is an auto road to within three miles, from which an uphill wagon road, that could be made passable for trucks at little cost, extends to the mine. The country is hilly and the elevation at tunnel No. 7 is 2539 feet. There is timber and a sawmill on the property. Tributaries of Indian Creek supply sufficient water all year for the compressor and plant.

The holdings comprise 32 claims, most of which are now patented. The deposit was located in 1892 and some work was done up to 1908, after which it changed hands. The present company began operations in 1916.

The country rock is gray schist and the deposits consist of mineralization along lines of fracture normal to the schist. The ore-zone trends southeastward and dips at an angle of 20° to 30°. It varies from 10′ to 80′ in width, chalcopyrite being the principal mineral. Very little oxide ore is encountered and that only in the upper workings. There is a strong gossan cropping on the surface. The ore varies from 2% to 18% copper and is said to average 6%. Over 1,000,000 tons of low-grade ore have been blocked out.

Since taken over by the present company, work has been confined to No. 7 tunnel, on the north side of the hill above the camp. It is the lowest working on the deposit and has been driven 3000 feet southeasterly. There are approximately 10,000 feet of crosscuts and drifts from this tunnel. Ore exposed on this level appears to be mostly pyrite and low in copper. Where raises have been put up good ore is exposed. A raise is now being driven to connect with tunnel No. 1, 150 feet vertically above No. 7. The raise is in ore. No. 1 tunnel was driven to cut the ore body underneath the gossan, from the north slope. At about 50 feet, a good vein was cut. Some oxidization is shown here and copper sulphate has been precipitated along the walls in several places. Tunnels Nos. 2 and 3 are short crosscuts, 20 feet and 40 feet vertically below No. 1 and are on the dip of the vein. Good ore is exposed in both.

The mine is equipped with steam plant to operate compressor and small electric light plant. The compressor is capable of carrying a dozen or more drills, and 8-inch air line running to the main tunnel. The mine plant is complete, with blacksmith shop, etc. Sixty men were employed up to 1918, but only two men on a contract were working during the past year.

Isabella Copper Mine. Owner, Isabella Copper Mining Company, Gazelle, California; Mrs. F. Moreland, president; R. E. Rader, secretary; home office, 3228 Adeline street, South Berkeley, California; controlled by R. E. Rader and Sons. Property consists of 120 acres in the East Fork mining district in section 34, T. 41 N., R. 7 W. It is reached by road up Rail Creek from Gregg's Ranch. Nearest railroad station is Gazelle, eighteen miles northeast. There is one large and one small vein or ledge. The width of the main one is about 50 feet. The vein filling consists of quartz and quartzite with sulphides and talc gouge. The ore is base, carrying gray copper and silver, with some gold.

The vein strikes northeast-southwest and dips 80°. It has been proven on the surface for over 4000 feet. Development work consists of a 45′ shaft, 95′ tunnel and 75′ drift on the vein. There are also two crosscut tunnels; No. 1 is in 235 feet and No. 2 is in 175 feet.

The mine is equipped with steam engine, 6″ x 8″ air compressor and Sullivan drill.

GOLD MINES—LODE.

Boulder Mine (formerly **Pumpkin Roller**). Owner, J. M. Campbell, Dunsmuir, California. This prospect is located in the Soda Creek mining district in section 30, T. 39 N., R. 3 W. Dunsmuir is the nearest town. Deposit consists of a free-milling quartz vein, averaging six feet in width, with porphyry footwall and heavy black slate hanging wall. Its strike is east-west and dip north. A 350-foot tunnel driven on the

vein reaches a maximum depth of 75 feet below the outcrop. There are four crosscuts. Preparations are being made to sink a shaft.

Cassadoga Mine. Owner, J. L. Corbett, Hilt, California. Property is situated in section 2, in the Cottonwood mining district, 10 miles west of Hilt, the nearest railroad point. The deposit is a quartz vein in granite country rock. The footwall is granite and hanging wall mica-schist and porphyry. The vein strikes east-west and dips at an angle of 70°. It has been proven on the surface for 3000 feet. A tunnel cuts the vein, which averages three feet in width, at a depth of 125 feet, and 450 feet of drift has been run. The owner estimates ore reserves of 8000 tons, valued at $10 per ton. The mine is equipped with a 2-stamp mill, run by steam power. Idle at present, only assessment work being done.

Champion Mine. Owners, W. F. and J. A. Hunter, Orleans, California. Property consists of nine claims in the Cottage Grove district in section 33, T. 12 N., R. 6 E. Reached by good trail of 11 miles from Orleans, the nearest town. Korbel, the nearest railroad point, is 60 miles southwest. Ten Eyck Creek furnishes plenty of water for power and the claims are timbered. The ore is free milling, but bunchy.

Development work consists of two tunnel levels, the lower one in 335 feet and the upper one 100 feet, with a raise between. The vein has been drifted on for 435 feet. All work has been done by hand, using car and wheelbarrow. Water ditches are complete and in use.

The mine is equipped with 1000-lb. single stamp in good condition for sampling and working rich bunches, also a 2-ton cyanide plant. It was worked from 1909 to 1917. All supplies have to be carried in by pack train.

Crawfish Gulch Quartz Mine. Owner, Sam Bratt, Oak Bar, California. Property consists of 40 acres located in the Oak Bar district in section 18, T. 45 N., R. 10 W., 39 miles west of Hornbrook, the nearest railroad point. There is a running stream and sufficient timber for working. The ore contains gold, silver and copper and is partly free and partly base. The vein strikes east-west, dips south and has an average width of two feet. The mine has been opened to a depth of 50 feet and 70 feet has been driven on the vein, and a 20 foot crosscut run. Total production to date $4,000.

Easter Mine. Owner, Frank Zollihofer, Yreka, California. Property is located in section 34, in the Humbug mining district. Rider Gulch supplies water and there is pine, fir and cedar on the claim. The country rock is granite and the deposit consists of a vein varying from 4″ to 12″ in width, proven on the surface for 600 feet.

Development consists of a 40 foot shaft and 300 foot tunnel. There are two levels opened with drifts of 80 feet and 300 feet respectively. The mine is equipped with arrastra and overshot wheel, water power being used. The owner works it alone.

Eureka and W. J. O. D. Owners, Wm. J. Durch, Rollins, California, and Dunphy Estate. Prospect in Liberty mining district. Nearest town Sawyers Bar. There is a 2-foot vein developed by one 230-foot and one 160-foot crosscut. Idle.

Little Bonsa Mine. Owner, C. N. Gordon, Yreka, California. Burks Blanket, a cross-claim, was located in 1920. The Little Bonsa is a pocket mine. The longest tunnel is 120 feet and the greatest depth reached below the outcrop is 50 feet. The largest pocket contained $1,200. Production to date about $8,000. Owner works it alone.

Mountain King 1-2-3. Owner, D. C. Weaver, Orleans, California. Property is in Prospect Hill mining district, 12 miles by trail from Orleans. Discovered in 1918. Only assessment work has been done.

Mountain Lilly Mine. Owner, G. A. Conzetti, Cecilville, California. Property consists of seven claims in the Salmon River district. Water is obtained from Salmon River and there is plenty of timber on the claims.

The deposit consists of four veins, striking east-west, of which two dip south and two north. The veins vary from four feet to twenty feet in width and have schist hanging wall, the country rock being schist and porphyry. The principal vein has been opened up to a depth of 150 feet and proven on the surface for 6000 feet. Water costs $120 per year.

The mine is equipped with 6-stamp mill, arrastra, two cars, tools and two blacksmith shops. The owner has been unable to save the values with present equipment, claiming a 75% loss in tailings. Idle.

Mount Vernon Consolidated Mine. Owners, James S. Dobyns and Cora N. Jacobs, Yreka, California. This mine has been operated at various times by different companies. James S. Dobyns expects to start operations again soon. The ore is free milling and the mine is equipped with a 5-stamp mill.

Oro Grande Mine (formerly **McKeen** or **Shasta**). Owners, Oro Grande Mining Company, J. R. McKinnie, president; Hugh McKinnie, secretary; home office, 637 Citizens National Bank Building, Los Angeles, California. Property is located in the Callahan mining district in section 36, T. 40 N., R. 9 W. Gazelle, the nearest railroad point, is 39 miles northeast. The holding includes 478 acres of patented land and 200 acres held by location. The country rock is granite and the deposit consists of quartz veins. The ore is base, but is amenable to cyanidation. There are five veins varying in width from eighteen inches to four feet. The principal vein strikes northeast-southwest and dips 85°. It has been proven on the surface for 4600 feet. About 8000 feet have been driven on the vein in five tunnels.

The owners estimate reserves of 50,000 tons valued at $8 per ton. Work is now confined to the two lower tunnels.

The property is equipped with mill, blacksmith shop, compressor building, warehouse, sawmill, and bunkhouse and boarding house capable of accommodating fifty men. The compressor will carry four drills and there is a good equipment of Sullivans and Waughs, steel track and cars.

Reduction plant includes Blake crusher, automatic feeder from ore bin to ball mill of 100 tons capacity, Senn amalgamator, K. and K. flotation machine, tanks, zinc-boxes, etc. The present owners have not operated the mill except in an experimental way, devoting efforts to

developing ore reserves. From mill tests the ore is thought to average $7 to $8 per ton. The property is reported to have produced $500,000, but old reports from the present mill only show about half that amount. There are no returns available of the several arrastras and 3-stamp mill at one time operated. The present tailing pile samples about $3 per ton. High costs prevent operation at present.

Pilot Knob and **Kearsarge** (formerly **Midwinter** and **Modoc**). Owner, R. G. Reeder, Yreka, California. Property consists of two claims in the Fool's Paradise district, in section 30, T. 46 No., R. 6 W. Yreka, 10 miles south, or Hornbrook, 9 miles east, are the nearest railroad points. The state highway passes within one-half mile of the property.

The deposit consists of quartz veins with porphyry and slate walls. The Midwinter vein strikes north-south and the Modoc east-west. They vary in width from a few inches to three feet. There are two shafts on the Midwinter, one thirty feet and one thirty-five feet deep and four tunnels, sixty-five feet, forty-five feet, thirty feet and seventy feet in length. The Modoc is developed by two tunnels, one thirty feet and one ninety-seven feet long. The ore is partly base and partly free, but mortars well when good. Several thousand dollars in gold have been taken from the claims.

Snowflake and **Little Gem**. Owner, Theo. H. Behuke, Rollin, California. Property consists of forty acres in Liberty mining district. Nearest town, Sawyers Bar. Deposit consists of a small vein striking northeast-southwest and dipping 31°. It is proven on the surface for 1000 feet. Porphyry, slate and quartzite constitute the country rock.

S. R. Crary Mine. Owner, S. R. Crary, Walker, California. Property consists of eighty acres, worked as a quartz and placer. The vein has been drifted on for 400 feet. Ore is free milling. Water for operating is scarce.

Victoria Quartz Mine. Owner, L. H. Brown, Dunsmuir, California. Property consists of forty acres in the Soda Creek district, in section 6, T. 39 N., R. 3 W. The nearest railroad station is Mott, one and one-half miles west. There are thirteen veins on the property varying in width from one to twelve feet. The vein filling is quartz carrying chalcopyrite, with some gold and silver. Country rock is diabase.

Development work consists of a 390 foot crosscut, a drift running north seventy feet and a forty foot raise and eighty foot winze.

GOLD MINES—PLACER AND HYDRAULIC.

Creosus Mine (formerly **Hickey Mine**). Owner, John Lenkert, Sawyers Bar, California. Placer on North Fork of Salmon River.

Gold Bank Mine. Owners, M. R. Ramsey and Jos. Frazier, Sawyers Bar, California.

Property consists of bench gravel in Liberty mining district. Discovered 1917. Water is obtained from Eddy's Gulch and mine is equipped with pipe, giant, derrick and water wheel. Production to date $2,400.

Gold Leaf Placer Mine (formerly **Joe King Mine**). Owner, Chas. Dillsham, Yreka, California. Property is in section 8, T. 45 N., R. 8 W., in the Hawkinsville mining district. Montague, eight miles east, is the nearest railroad point. Located in 1918. Both coarse and fine gold occur, but water is very scarce.

James Frazier Mine. Owner, James Frazier, Sawyers Bar, California. Placer mine idle for past four years.

Multo in Parvo Mine. Owners, Wm. Wike and Sam Mathias, Sawyers Bar. Placer mine in Liberty mining district. Idle at present.

Only Hope Placer Mine. Owners, W. L. McClunghry and Fred Martin. Located in Humbug mining district. Idle and probably abandoned.

Pennsylvania Placer. Owner, Frank Edwards, Copper, California. Nearest town, Jacksonville, Oregon. Property consists of six claims in the Elliott Creek district. Only assessment work is being done.

Pond Water Mine. Owner, H. H. Albard, Blue Nose, California. Property consists of one claim located in the Dillon mining district in section 20, T. 13 N., R. 6 E. Somes Bar is the nearest town. Trinidad, the nearest railroad point, is about fifty miles south. The deposit consists of gravel carrying fine and coarse gold. Ditch water rights are owned and the mine is equipped with pipe and giant. Assessment work only is being done.

Rocky Point Mine. Owners, Hicks and McCarthy, Scotts Bar. Property is situated in section 32, T. 45 N., R. 10 W., $3\frac{1}{2}$ miles south of Scotts Bar. The deposit is old channel gravel, which is hydraulicked.

QUICKSILVER.

Hutton Quicksilver Lease (formerly **Herzog** and **Morgan** Mines). Ten men have been employed on development work at this mine near Gottville. A 25-ton rotary furnace is to be installed during the summer.

TEHAMA COUNTY.

Tehama County is situated at the northern end of the Sacramento Valley, and reaches from the summit of the Sierras on the east to the crest of the Coast Range Mountains on the west. The eastern portion is covered with lava flows. The central part through which the Sacramento River flows, is composed largely of unconsolidated gravels, sands and clays. In the western part where most of the mineral deposits occur, sandstones, shales and the metamorphic rocks and serpentines of the Coast Range are found.

The county has never been a large producer of mineral products, the most important one, prior to the period of the war having been mineral water. During the war chrome mining was active, but for the past year there has been no production.

The possibility of finding commercial quantities of petroleum in this section has attracted more attention than the development, under present conditions, of known occurrences of other minerals, and for this reason field work in Tehama County during 1920 was devoted to the investigation of formations and structural features of economic importance to oil operators. The results of this work will be found in Bulletin No. 89.

The Fifteenth Report of the State Mineralogist (1915-1916) contains a general description of the mines and mineral resources of the county. Under later date Bulletin No. 76 covers the manganese and chromite deposits exclusively and Preliminary Report No. 7, the clay industry.

The mineral resources of the county include brick-clay, chromite, copper, gold, manganese, marble, mineral water, salt, silver and miscellaneous stone. Borax was first discovered in California in the waters of Tuscan Springs, Tehama County, in 1856.

The total value of Tehama's mineral products for the year 1914 was $300. In the table following the values for 1917, 1918 and 1919 are given for comparative purposes.

Commercial production for 1917 was as follows:

Substance	Amount	Value
Chromite	2053 tons	$41,646
Stone, miscellaneous		2,373
Total value		$44,019

Commercial production for 1918 was as follows:

Substance	Amount	Value
Chromite	3261 tons	$152,291
Stone, miscellaneous		2,500
Other minerals		2,800
Total value		$157,591

Commercial production for 1919 was as follows:

Stone, miscellaneous		$7,500
Other minerals		1,500
Total value		$9,000

TRINITY COUNTY.

The principal mineral product of Trinity County is native gold. The four dredges within its borders have continued to operate despite the adverse conditions under which all gold producers are laboring. The county is well watered and most of the small placer mines are so situated that they have felt the effects of the past dry season to a less degree than the mines in the other counties of this district.

There was little loss of time due to power restrictive measures as the power companies serving most of the operators in Trinity County were able to supply all demands for power throughout the year. The occasional finding of rich pockets in the Weaverville district, which is famous as a pocket country, has helped to sustain production and it is probable that Trinity County will show a smaller proportional decrease in the value of its 1920 mineral production than any other county of the northern California division. It was one of the few counties that showed an increase in gold production in 1917 when, as a rule, a marked falling off in gold output was reported throughout the state.

Its mineral resources include asbestos, barytes, chromite, copper, gold, mineral water, platinum, quicksilver, silver and miscellaneous stone. Trinity County is without railroads and increased transportation facilities are needed to further develop its varied resources.

The following table gives its commercial production for the years 1917, 1918 and 1919.

Commercial output for 1917 was:

Substance	Amount	Value
Chromite	242 tons	$6,325
Gold		602,048
Platinum	50 oz.	3,283
Silver		10,021
Stone, miscellaneous		7,718
Other minerals*		358,447
Total value		$987,842

*Includes copper, manganese, mineral water, quicksilver.

Commercial output for 1918 was:

Substance	Amount	Value
Chromite	1814 tons	$75,660
Gold		444,729
Platinum	41 oz.	3,136
Silver		6,912
Stone, miscellaneous		1,513
Other minerals*		175,574
Total value		$707,524

*Includes copper, mineral water, and quicksilver.

Commercial output for 1919 was:

Substance	Value
Gold	$500,000
Silver	[1]7,500
Stone, miscellaneous	11,839
Other minerals*	17,444
Total value	$536,783

[1]Estimated.
*Includes copper, mineral water, platinum, and quicksilver.

A general report on the mines and mineral resources of the county is contained in the Fourteenth Report of the State Mineralogist. Special reports of later date include Bulletin No. 76 (1918), which describes the manganese and chrome deposits; Bulletin No. 85, "Platinum and Allied Metals in California" (1918), which contains a detailed description of the platinum deposits in the county, and Bulletin No. 78 (1918), covering the occurrences of quicksilver.

Field work during the season of 1920 was mainly devoted to investigation of the petroleum possibilities of the northern counties. With the exception of the dredges which were visited, the following notes on the mining developments of the past year have been obtained principally through correspondence. They are offered as a supplement to former publications, giving changes of ownership and data on properties not formerly of record.

GOLD MINES—LODE.

Blue Jay (formerly **Knabe**). Owner J. F. Gifford, Lewiston, California. Property consists of three claims, the Blue Jay, Confidence and Mountain Echo, a total area of sixty acres, located in the Eastern mining district. Elevation 3500 feet. Country rock porphyry and slate. Ore is free milling with some sulphides.

Bonanza King Mine (formerly **Trinity Bonanza King**). Owners, Foster Gold Mining Company, C. G. Foster, president; E. W. Harmon, secretary; home office, 112 Steuart street, San Francisco, California; David E. Cavagnero, superintendent, post office, Carrville, California. The mine is in section 14, T. 37 N., R. 7 W., in the Trinity Center mining district. Delta, the nearest railroad point, is 33 miles east. There is an old wagon road about nine miles long with heavy grades, from Trinity Center but supplies are packed five miles over a trail from Carrville. The mine has an elevation of 6500 feet. There is sufficient pine on the property for mine timbers. The country is rugged and the property being near the top of a ridge 7200 feet high, considerable trouble is experienced in winter, due to heavy snowslides.

The mine was originally located in 1886 and was formerly worked by Treadwell and associates. It was recently reopened and a new mill was constructed in 1915. The property embraces 28 claims mostly unpatented, also section 36 on Clear Creek, 640 acres known as Bugle Hill placer. The latter is undeveloped and not being worked. The total holding is about 2500 acres.

Country rock is gabbro and schist. The deposit consists of a quartz vein in chloritic schist. A serpentine dike 50 feet wide cuts across the schist, striking N. 20° W. The strike of the vein is with the schist N. 60° W. The serpentine dike, or intrusion, is evidently responsible for the pay-shoots as the shoot appears to follow the serpentine contact and extends for about 400 feet to either side of the intersection with the schist. The quartz is hard and white and the gold free milling. It is often coarse enough to be detected with the naked eye. The best values are found in talcose quartz along the contact. There is a gouge along both walls from six inches to one foot thick.

The main tunnel, No. 4, is the working adit. It is driven north 1472 feet to cut the vein. There is a 960 foot drift northwest on the

vein at this level. The serpentine dike cuts the schist 700 feet from the portal of No. 4.

No. 2 tunnel is 110 feet on the dip of the vein (about 70°), above No. 4. No. 1 raise from the main tunnel is 350 feet northwest of the intersection of crosscut and drift and No. 2 raise is 400 feet northwest of No. 1 raise.

At 110 feet on level of No. 2 tunnel drifts are being run from both raises, on ore, to connect them. A drift being run northwest 250 feet above No. 2 tunnel, shows ten feet of quartz in the face. Assays here are reported to run up to $500 per ton. An intermediate drift was run from the raise on a vein varying from four feet to six feet in width.

Air drills are used in mining. The company owns a power line six miles long, water power from East Fork of Trinity River being used for generating electricity. There is an air compressor for five drills, blacksmith and machine shop, and electric tram in the main adit, which hauls a train of one-ton cars.

The reduction equipment consists of Blake jaw crusher, twenty 1000-pound stamps, dropping 105 times per minute, and four amalgamation plates. Tailings are run to waste. The old 40-stamp mill has been dismantled and the tramway to it is out of commission, but still in place. The new mill is at the portal of the main adit. Shortage of water has caused partial or complete suspension of operations in the summer for the past two years. In October, 1920, operations were again commenced after a three months shutdown. Labor has also been difficult to obtain.

Globe Mine. The Globe Mines at Dedrick have been operated on a small scale during the greater part of the year, by Buckley Wells, Hobart Building, San Francisco. The mill and cyanide plant were in operation for three months prior to December 1, when it was closed down. It is reported that the Globe and adjoining Chloride-Baily mine have been sold to J. N. Kilner, of New York, and Chas. Farmer, of Hayfork. The mill and cyanide plant were retained by Wells and will be torn down and transferred to one of his properties in Nevada.

Golden Jubilee Mine. Owners, McCormick-Saeltzer Company, Redding, California. This property has been idle for the past four years.

Jennings Gulch Mine. W. C. Dohrman, president of company. Idle past two years.

Little Buster Mine (formerly **West Point**). Owner, Frank Gallagher, West Point; post office, Lewiston, California. Property is in the Deadwood mining district. Redding, the nearest railroad point, is twenty miles easterly by good road. There is plenty of good timber and water is obtained from Little South Fork of Deadwood Creek. Country rock, porphyry and black slate. The deposit consists of a 5-foot vein proven on the surface for 1500 feet. The greatest depth opened on the vein is fifty feet. It has been drifted on for 200 feet.

May Blossom Mine. Owners, Joseph and George Kapusta, Lewiston, California. Property consists of forty acres, located in the Minersville district, in section 16, T. 34 N., R. 8 W. Elevation 2500 feet. The claims are timbered with pine and fir, but the water supply is

small. The deposit consists of a small vein averaging six inches in width carrying free gold. It strikes northwest-southeast and dips 80° and has been proven on the surface for 100 feet. A tunnel cuts the vein at a depth of 55 feet at which point there is a ten foot drift.

New Blue Jay Mining Company (formerly **Blue Jay Mine**). Owners, J. B. Batz and Company, Bakersfield, California; J. B. Batz, president; Jud Jordan, secretary. The mine is located in the Coffee Creek district, in section 13, T. 37 N., R. 8 W., about 2 miles from Carrville. It is thirty miles easterly over toll road to Delta, the nearest railroad point. The property lies at an elevation of 3000 feet and is well timbered with pine, fir, cedar, oak and ash. Water is obtained from Morrison Gulch and by ditches from Little Boulder Creek, both tributaries of Coffee Creek.

Slate and porphyry occur on the east side of the section and serpentine on the west. The dike rock, carrying the gold, is a fine grained gray porphyry classed as a vogesite porphyry. Manganese and copper occur wherever the gold is found. Ore is free milling. The vein is narrow and irregular, varying from one-half inch to one foot in width and probably averaging about six inches. It strikes a little east of north and dips about 20° east. Proven on the surface for 100 feet.

There are three levels, the lower level or working tunnel is 990 feet in length and the upper tunnels are about 130 feet each. There are two crosscuts of 50 feet each, one 30 foot winze and raises from each level through to the surface. The ore has been practically all stoped from the working level to the surface for the entire length of the shoot or 50 feet in length by 130 feet in height, and there is no ore in sight in the present workings.

The mine is equipped with a Graupner mill, manufactured by the Joshua Hendy Company of San Francisco.

The Blue Jay mine was discovered by Graves Brothers of Carrville, who found a rich vein leading to a pocket containing about $60,000. The find was the cause of the rush to Coffee Creek in 1897. Several other pockets have been extracted by the present owners and later by lessees of the property but it has been practically idle for the past four years.

Phillips Group Quartz Claims (formerly **Phillips and Hensley Group**). Owner, J. W. Phillips, Lewiston, California. Property consists of three claims, the Florence, Laurel and McWilliam, located in the Indian Creek district, in Sec. 14, T. 32 N., R. 9 W. Redding, the nearest railroad point, is 45 miles easterly, over two miles of trail and forty-three miles of good road. The area of the claims is sixty acres and there is an abundance of fir, pine and oak. Spring Gulch furnishes sufficient water for milling purposes. This mine was discovered about 1886. It was closed down in 1894 due to litigation, but was reopened in 1916. Country rock is mica schist, cut in places by limestone dikes. The claims cover the lode for 4500 feet. Two veins, the Florence and Laurel, have been developed. The filling is quartz, containing both free and base ore.

The maximum width of the principal vein is three feet with an average of about eighteen inches. It strikes northwest-southeast, with

vertical dip, and has been proven on the surface for 500 feet. The pay-shoot is 200 feet in length by eighteen inches wide. The ore has been opened up on three levels. No. 1 tunnel is in 150 feet, No. 2 tunnel, 290 feet, and No. 3 tunnel 200 feet. The greatest depth attained below the outcrop is 300 feet. The owner estimates there is 1600 tons of ore, valued at $45 per ton, blocked out.

San Miguel, Snowshoe and Montezuma. Owner, Paul Potillo, Weaverville, California. Prospect discovered in 1898 and reached by trail only. Located in the West Weaver Mountains. Bally district. Deposit consists of a quartz vein four inches to eighteen inches in width, in granite. Development work consists of a 200 foot tunnel.

Sherwood Group Quartz Mine. Owners, James W. and John H. Bartlett, Denny, California. Property consists of four claims, having a total area of eighty acres, situated in the New River mining district. Helena is the nearest town. Eureka, the nearest railroad point is 100 miles westerly. A wagon road extends from Eureka to Burnt Ranch and a trail from the latter point to the mine. The claims have an elevation of 4500 feet and are partly timbered and partly open. Water is obtained from Battle Creek.

There is one well defined quartz vein of fairly uniform width averaging about nine inches. It strikes northwest-southeast and dips at an angle of about 23°. It has been proven on the surface for 700 feet. Practically but one tunnel level has been worked, from which two winzes have been put down, 90 feet and 50 feet respectively.

The greatest length driven on the vein is 500 feet and the greatest depth reached is 150 feet. The pay-shoot was about 200 feet long. All ore was milled at the mine. Power was furnished by a Pelton wheel run by water from Battle Creek. The mine is said to have produced $100,000 to date. Idle for past three years.

Smith-Cromwell Mine. Property was sold to S. H. Parkhurst, the present owner. Idle.

Sunny Slope Mine. Owner, Sunny Slope Mines Company, O. K. Paup, president, F. A. Washberg, secretary, French Gulch. Property consists of five unpatented claims in the Minersville district on unsurveyed land in township 34 N., R. 8 W. The mine is 35 miles northwest of Redding, the nearest railroad point, and six miles north of French Gulch, on the Deadwood road. The grades to the mine are heavy and the road narrow. The claims have an elevation of 4300 feet, and are in the Shasta National Forest and covered with pine and fir. A spring supplies enough water for camp purposes. Country rock is meta-andesite and slate, the deposit being a fault vein lying along the contact. The andesite outcrops prominently and forms the hanging wall of the vein. The latter is a well defined quartz vein highly oxidized on the surface and from three feet to six feet wide, where exposed. No sulphides are visible and the ore is said to be free milling. The foot wall is black slate. The vein strikes N. 70° W. and dips 35° toward the north. It has been exposed on the surface for 300 feet by open cuts, 100 feet being run along the vein. A shaft was sunk from the open cut. A crosscut 56 feet vertically below the outcrop

and 100 feet south of it, now in 200 feet in the slate formation, is being run to cut the vein at depth. Work is done with hand tools, wheelbarrow and shovel. One man employed.

GOLD MINES—PLACER AND HYDRAULIC.

Battle Peak Mine. Owner N. L. Hildrick, Copper, California. Property is located in the Copper Creek district. It is 40 miles from Delta, the nearest railroad point, 36 by good road and 4 miles by fair trail. Battle Creek furnishes the water supply which is good in early spring. Claims have an elevation of 7000 feet. The mine was reopened in 1917.

Champion Placer Mine. Owners, C. Bradbury and John Hagelmann, Junction City, California. Property is situated in the Weaverville mining district, East Weaver Creek furnishing the water supply. Equipped with pipe and giant. Idle.

Democrat Gulch Mine. Owners Armentrout Brothers, Weaverville, California. Property consists of the Effie Bull, Lucky Strike, Just in Time, Hitchens and McKinzey and Hoag placer mine claims, a total area of 640 acres. It has been worked since 1900 by hydraulicking. Water is used under 175 foot pressure, but the supply is limited and the length of run is dependent on the winter rains and snowfall.

Gold Ridge No. 1. Owner, unknown. The surface of this property in the Minersville district in township 25 N., R. 8 W., was piped off in 1912. Prospecting only since that time. Nearest town is Lewiston.

Linda Marie Placer Mine. Owner, C. H. Mathews, Forest Glen, California. Property consists of 100 acres patented in 1915, and situated in sections 32, 33, T. 1 S., R. 8 E., in the South Fork mining district. Eureka and Red Bluff, railroad points, are 86 miles distant, west and east respectively.

The property has an elevation of 2770 feet, the deposit consisting of bench gravel about 50 feet above the present level of Marie Creek, a tributary of South Fork Trinity River. Country rock is schist and slate.

McDonald Placer Mine. This property has been acquired by the Estabrook Gold Dredging Company, Trinity Center, California.

Stevens Gulch Placer Mine. Owner, George Zinn, Coffee, California. Property is in the Coffee Creek district on unsurveyed land in township 38 N., R. 9 W. The nearest town is Carrville. It is in the Shasta National Forest and lies at an elevation of close to 6000 feet. Local water supply.

Tom Bell Placer Mine. Owner, W. W. Young, Weaverville, California. Property is in the Weaverville district in sections 5, 6, T. 33 N., R. 9 W. The claims were patented in 1874. It was last worked in 1863 at which time water was rented from the Howe ditch. Deposit consists of clay and gravel.

VOLCANIC ASH.

Liberty Bell Mine. Owners, Frank Sarcletti, Joe Merciari, Louis Sarcletti and Joe Dallatorre, French Gulch, California; home office, Redding. Property is located in section 13, T. 34 N., R. 8 W., in the Minersville district and is 35 miles northwest of Redding, the nearest railroad point. The claims have an elevation of 4000 feet. There is ample pine and fir for mining and spring water in Little Papoose Creek below the mine. There are five claims located on a steep hillside about 500 feet below the summit of the ridge. The deposit consists of a bed of volcanic ash (andesitic), lying between a slate footwall and andesite hanging wall. The strike is west with a flat dip to the south. A tunnel driven 100 feet in the slate-andesite contact cuts the volcanic ash at about forty feet and it is exposed in the tunnel for sixty feet, gradually widening out to four feet at the face. The owners are building a three mile trail to connect with the auto road. No shipments have been made as yet. There is a quartz outcrop on the ridge 150 feet above the tunnel from which a sample is reported to have assayed $15 in gold per ton. It is expected to cut this vein by driving the tunnel ahead.

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